IRON AND STEEL ENGINEER

J. F. KELLY, Editor

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EDITORIALS

THE STEEL MILL ELECTRICAL ENGINEER OF TODAY.

The dawn of a new era might be aptly termed of the position of the Steel Mill Electrical Engineer of today. The advent of the electrification of mills was in the application of electricity to auxiliaries, lighting and in general small equipment. Under these conditions, the man in charge of the relatively small gang required for maintenance was usually a practical electrician and the requirements were naturally limited. The ramifications of electrical applications have so expanded that today an electrical engineer is now required, who can no longer restrict himself to a knowledge of electrical machinery, but must be in a position to render service electrically. To do this, he must understand the various operations he is applying his knowledge to through electrical means. To acquire this knowledge, he selects for his associates engineers in the allied steel mill activities. This makes an organization as The Iron and Steel Electrical Engineers, a clearing house of knowledge where all engineers having a common interest in the advancement of the steel industry through such agencies as electricity, fuel and mechanical progress, etc., may meet collectively to exchange interrelated facts and personally improve, so that their value to their respective organizations will increase individually. No longer is it possible to discuss problems in the abstract, where service is to be rendered, which is the reason for the expansion of the Association of Iron and Steel Electrical Engineers, to embracing all engineers whose efforts are being co-ordinated to reach an ideal—"the greatest and most economical steel mill production in the world."

STRENGTH OF GEAR TEETH

By E. KIEFT

Supplement to original published in the Iron & Steel Engineer, September, 1926.

In practice we observe quite frequently that gear teeth are stressed beyond the elastic limit, for they show deformation of shape, sometimes to such an extent that metal is worked toward the edge of the teeth forming fins or other irregularities on the outside of the tooth. It is also experienced that the wear of the gear teeth is very much dependent upon the kind of lubricant and therefore vast amounts of energy are lost due to improper lubrication for excessive wear is due to friction and impact energy being converted into heat.

Much has been written and said about heat losses due to improper combustion as indicated by the stack temperatures, carbon in the ash, excess air and by several other visible and tangible means, which has lead to constructive propaganda for the sake of fuel conservation. We can help the good work commenced by the combustion engineer considerable by giving some special attention to the apparent invisible losses caused by neglecting the waste of energy due to impact and friction of the moving parts of machinery. Special attention and regulation of the inertial effects of the moving bodies will in many cases reduce the fuel wastage even more than anything so far obtained with combustion regulation.

The inertial effects encountered in mechanical engineering are also encountered in electrical engineering, where we use the expressions inductance and capacitance instead of inertial resistance and energy storage. The same methods of reasoning and formulae apply in the different branches of engineering and physics.

The stresses produced in cables of hoisting machinery by acceleration effects may exceed the load stresses by several hundred per cent, i.e., let a load of 60,000 lbs. be accelerated from rest to a velocity of four feet per second in 0.01 of a second, then the total force acting on the steel cable is not 60,000 lbs. but $60{,}000\ (1 + \frac{400}{32.2})$ or 13.4 times 60,000 lbs. = 804,000 lbs., which accounts for occasional break downs of steel cables or other parts of the hoisting machinery although the load may be apparently far below the nominal capacity of the hoist; this shows the importance of careful men and careful operation in order to obtain not only economy, but also maximum safety.

It may also be of interest to note that the last sentence on page 413 of the I. & S. September issue should read: The load stresses (instead of the impact stresses) reduce 50% for $h = .707\ t$ see Fig. 1 and the impact stresses only 16% as shown under formula (8) page 420; further that load pressures and horsepower computed by means of formulas (1) and (2) give satisfactory results for gears of machinery subject to heavy duty. The impact formula (8) is to be recommended for investigation and analyzing impact effects.

TWENTY-SECOND ANNUAL MEETING

By GEO. H. SCHAEFFER*

Members and Friends of the Association of Iron and Steel Electrical Engineers:

The inspection and meeting today constitute the Twenty-second annual meeting of our Association. It was made possible by the liberal policy of the Bethlehem Steel Corporation. It is by no means a new policy for this Corporation, for our membership, under the auspices of the Philadelphia Section, has visited the Lehigh, Saucon and Sparrows Point plants.

The Association highly approves of these "Inspection Trips" because they give the engineers, of which our Association is largely composed, first

*President, A. I. & S. E. E. Presented before Johnstown meeting, September 25, 1926.

(Continued on page 459)

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Preliminary Report of the Standardization Committee of the Association of Iron and Steel Electrical Engineers for Year 1926

The Standardized Commutating Pole Mill Type Motor

By A. C. CUMMINS, Chairman*

THE work of the Standardization Committee in 1926 was concerned with formulating standardized dimensions for future designs of interpole mill type motors for steel mill applications.

Rumors of new mill type motor design became prevalent during the Fall of 1925, and one of the manufacturers exhibited drawings and models of a new motor to many members of the Association President Schaeffer called a meeting of the General Committees of the Association in December, 1925, for the purpose of discussing this development and determining what policy the Association should pursue. This meeting was held at the Duquesne Works of the Carnegie Steel Co., and was attended by about fifty active members and manufacturers' representatives. After a thorough discussion of the subject a motion was passed recommending that the Board of Directors authorize the Standardization Committee to take definite steps toward securing the co-operation of the manufacturers to standardize any new mill motor designs that might be developed for steel mill service. The Board of Directors took the necessary action at their January Meeting and active work was started immediately thereafter.

The first step was to communicate with the presidents of American steel producing companies, stating the object of the proposed activity and asking for their approval and moral support. The replies received were quite gratifying and there are now in the Committee files 102 letters from Executive Officers of Steel Companies which are, with two exceptions, unanimous in their approval of the project and in many cases offer assistance if it should prove necessary. The Committee stated in this correspondence with the Steel Mill Presidents that the Association would limit the scope of standardization to ratings and external dimensions, as it was not desired to hamper designing engineers in employing ingenuity as far as the electrical and mechanical characteristics of motors were concerned.

It was also stated that the attitude of the Association was not one of requesting manufacturers to develop a new line of motors at this time or at any future time, but that when it was found necessary to bring out new designs, the Association requested that such motors be built so that they would be interchangeable as complete units, regardless of the name of the manufacturer.

Letters were also written to the Presidents of the Electrical Manufacturing Companies stating the results of the Meeting in December, the action of the Board of Directors, and the correspondence with the Presidents of the Steel Companies. It was requested that they appoint representatives to confer with the Committee with the idea of setting up definite standards which would give all manufacturers an equal chance to build a standardized commutating motor. In the meantime, a questionnaire was prepared which was forwarded to all the active members of the Association in an endeavor to secure the general opinion on the advisability of incorporating certain features in mill type motors which it was felt would have to be decided by the Committee before the Engineers of the Manufacturing Companies could have a foundation on which to start their part of the work.

Figure 1 is a Table of the questions and also a summary of the answers. An inspection of this table will show that the majority answer these questions in a way that indicates they desire all flexibility possible in the new designs. The questionnaire was of assistance in deciding a number of points which the engineers of the manufacturers brought up.

The preliminary work listed above occupied all of the months of January and February and led up to a series of conferences of which the first was held in the Hotel Cleveland, Cleveland, Ohio, on March 12, 1926. Representatives of the Electro-Dynamic Co., Reliance Elect. & Engineering Co, Allis Chalmers Mfg. Co., Crocker Wheeler Elect. Mfg. Co., Pawling & Harnischfeger Corp., General Electric Co., and Westinghouse Elect. & Mfg. Co., were present. The Association's representatives were J. E. Fries, of the Tennessee Coal, Iron, and R. R. Co.; W. S. Hall, Illinois Steel Co.; A. G. Place, Youngstown Sheet & Tube Co.; E. S. Jefferies, Steel Company of Canada; R. H. Keil, Jones & Laughlin Steel Corp.; A. J. Standing, Bethlehem Steel Co., R. S. Shoemaker, American Rolling Mill Co.; W. T. Snyder, National Tube Co.; Jas. Farrington, Wheeling Steel Corp.; A. C. Cummins, Carnegie Steel Co.; G. H. Schaeffer, Carpenter Steel Co., and J. F. Kelly, Business Mgr. of the Association.

The Cleveland Meeting was followed by a meeting in Duquesne, April 16, attended by the same group. This in turn was followed by a meeting in Buffalo, April 24. A fourth meeting was held in Duquesne on May 7. The fifth was also held in Duquesne on June 4. This last meeting was attended chiefly by representatives of the manufacturing companies as its purpose was to determine

*Electrical Supt., Carnegie Steel Co., Duquesne, Pa.

A. I. & S. E. E. QUESTIONNAIRE OF MILL MOTOR STANDARDIZATION

1) Will Steel Mill Electrical Engineers be satisfied with box type non-split frame mill type motors, even if they can be purchased for 20% less money, are lighter, and occupy less space?
2) Do Steel Mill Electrical Engineers desire mill type motors designed to accommodate anti-friction bearings only rather than motors designed to permit the installation of either anti-friction or sleeve bearings?
3) If Motors are designed with frames which will accommodate either sleeve or anti-friction bearings, must the arrangement of bearings be such as to permit the use of either type in the same frame interchangeably?
4) Shall the new mill type motor have bearings provided with sufficient end thrust capacity to permit the use of single spiral seven to ten degree helical gearing?
5) Can the number of ratings be reduced? If you believe it can, submit a list of one-hour ratings, which will meet your requirements up to 225-H.P.
6) Do you believe increased speeds for mill type motors are desirable?
7) Do you desire motors having armatures built on a spider and commutators mounted on an extension thereof?
8) The committee will be grateful for any other suggestions that you may have covering features which would be desirable to have included in improved designs of mill type motors. Such suggestions should be made with the idea of solving general maintenance problems rather than specific cases.

SUMMARY OF REPLIES

QUESTION	#1			#2			#3			#4			#5			#6			#7		
	YES	NO	NO VOTE	YES	NO	NO VOTE	YES	NO	NO VOTE	YES	NO	NO VOTE	YES	NO	NO VOTE	YES	NO	NO VOTE	YES	NO	NO VOTE
IDENTIFIED	5	70	—	19	55	1	67	6	2	51	21	3	33	27	15	7	67	1	72	3	—
UNIDENTIFIED	-	63	—	27	36	—	53	7	3	40	21	2	30	24	9	8	51	4	59	3	1
TOTAL	5	133	—	46	91	1	120	13	5	91	42	5	63	51	24	15	118	5	131	6	1

FIG. 1.

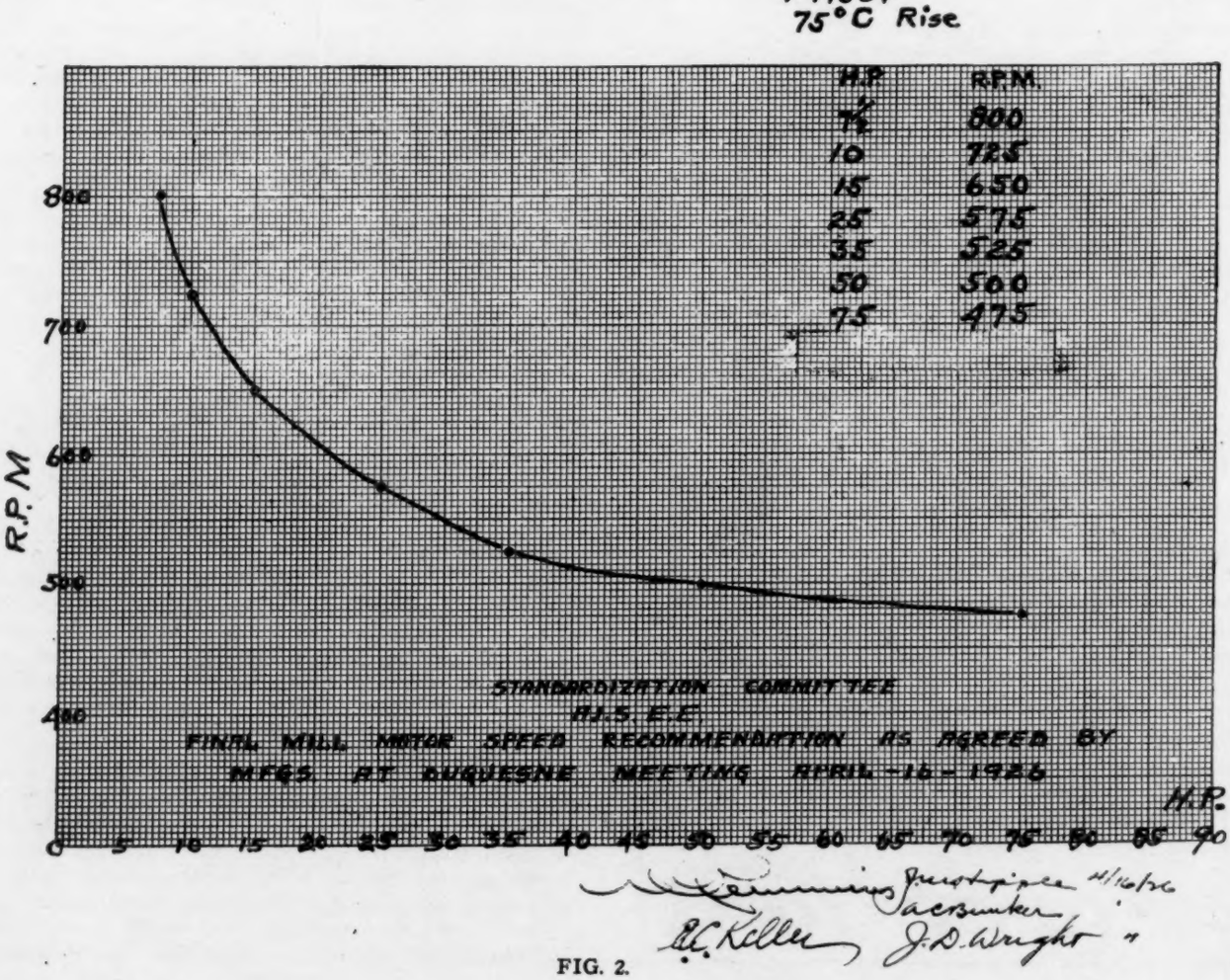


FIG. 2.

whether the work of the designing engineers had progressed to a point where any formal announcement could be made at the Annual Convention, and to straighten out one or two errors that had been assimilated up to this point. The sixth meeting was held in Chicago at the Convention and was attended by Association Members at large, as well as the

MILL RATINGS

Frame	H.P.	R.P.M.	Torque in Ft. Lbs.
A	7½	800	49
B	10	725	72
C	15	650	121
D	25	575	228
E	35	525	350
F	50	500	430
G	75	475	830

SIZE	H.P. RATINGS MILL RATING 1HR 75°			RATED SPEEDS SER. MOTORS MILL RATING			HORSE POWER AND SPEED RATINGS															
	W.E.&M.	G.E.	C.W.	W.E.&M.	G.E.	C.W.	W.E.&M. MILL RATING 1HR.	75°	G.E. MILL RATING 1HR	75°	C.W. MILL RATING 1HR	75°	A.I.&S.E.E. * MILL RATING 1 HR.	75°	RATIO CRANE TO MILL	CRANE RATING ½ HR.	75°	PATTERSON MOTOR PRINCIPLE MILL RATING 1 HR	75°	RATIO CRANE TO MILL	CRANE RATING ½ HR.	75°
1	6	4	8	700	975	670	6	700	4	975	8	670	7½	800	1.33	10	690	5	850	1.34	6¾	730
2	12	9	11	700	875	1015	12	700	9	875	11	1015	10	725	1.30	13	625	10	765	1.30	13	825
3	20	13	16	600	800	620	20	600	13	800	16	620	15	650	1.33	20	560	15	675	1.30	19½	540
4	30	20	25	525	725	590	30	525	20	725	25	590	25	575	1.28	33	495	25	550	1.34	35	475
5	50	30	36	475	625	565	50	475	30	625	36	565	35	525	1.29	45	455	40	500	1.32	55	430
6	70	40	47	440	550	550	70	440	40	550	47	550	50	500	1.30	65	430	65	475	1.32	86	440
7	85	70	66	475	500	525	85	475	70	500	66	525	75	475	1.33	100	410	100	480	1.32	132	390
8	100	85	90	500	500	500	100	500	85	500	90	500										
9	150	100	120	370	500	465	150	370	100	500	120	465										
10	185	175	175	480	400	430	185	480	175	400	175	430										

FIG. 3.

COMPARISON OF MILL MOTOR RATINGS & SPEEDS—STANDARDIZATION COMMITTEE ASSOCIATION OF IRON & STEEL ELEC. ENGINEERS

March 9, 1926

NOTE: MILL RATING IS BASIC RATING—CRANE RATING ONLY APPROXIMATE

A. I. & S. E. E. RATINGS AS SUGGESTED BY REPLIES TO QUESTIONNAIRE

CORRECTED IN ACCORDANCE WITH CLEVELAND MEETING RECOMMENDATIONS—Mar-18-26

Committee. At this time the announcement was made of the progress up to June 4. The seventh meeting was held in Duquesne, August 24.

Definite agreements have been reached on all points which are listed in Fig. 10. This includes all external features covered by our program in connection with the motors without axle shafts. There are still some minor details which must be worked out by the draughting forces of the Electrical Manufacturing Companies before definite dimensions can be announced in regard to the axle shaft sleeve bearing sizes and method of mounting axle shaft anti-friction bearings. It is expected that there will be two more meetings before the work is finally concluded.

To those who read this report a summary of the outstanding features that it is planned to include in the proposed standardized interpole motor will be of interest. We will therefore include in the report a summary of these features.

Ratings:

Standardization of the interpole mill type motor at the present time has included the following ratings based on the standard one hour, 75 degree temperature rise.

It is expected that the corresponding crane ratings will be approximately as follows:

Frame	H.P.	R.P.M.	Torque in Ft. Lbs.
A	10	690	76
B	13	625	109
C	20	560	188
D	33	495	350
E	45	455	520
F	65	430	795
G	100	410	1280

Figure 2 is a curve showing relation between rated H.P. and speed. Figure 3 gives a table comparing different ratings now on the market with those proposed by the Committee.

It should be understood that crane ratings will probably be adjusted slightly after the motors are designed, as the designers are attempting to develop motors which will primarily meet the mill ratings as published above.

It may be well to state that the aim of the designing engineers has been to plan a mill type motor which would be logically designed. In other words, commutator heating, core heating, and field heating should reach the limiting temperature rise simultaneously, and the rating as limited by heating not exceed commutating ability. In present designs fre-

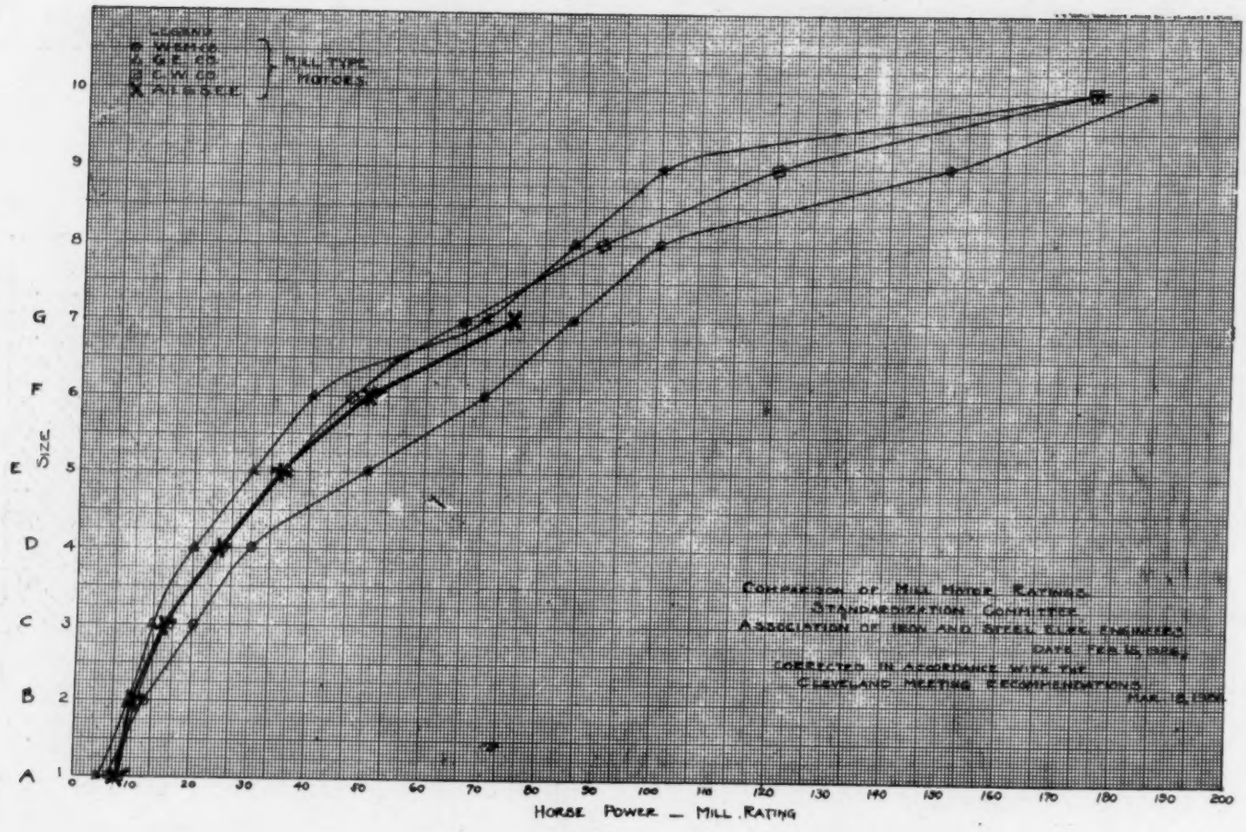

LEGEND
W.E.M.CO.
G.E. CO.
C.W. CO.
A.I.&S.E.E.
MILL TYPE MOTORS
SIZE
A
B
C
D
E
F
G
COMPARISON OF MILL MOTOR RATINGS.
STANDARDIZATION COMMITTEE
ASSOCIATION OF IRON AND STEEL ELEC. ENGINEERS
DATE FEB 16, 1926.
CORRECTED IN ACCORDANCE WITH THE
CLEVELAND MEETING RECOMMENDATIONS
MAR. 8, 1926
HORSE POWER — MILL RATING

FIG. 4.

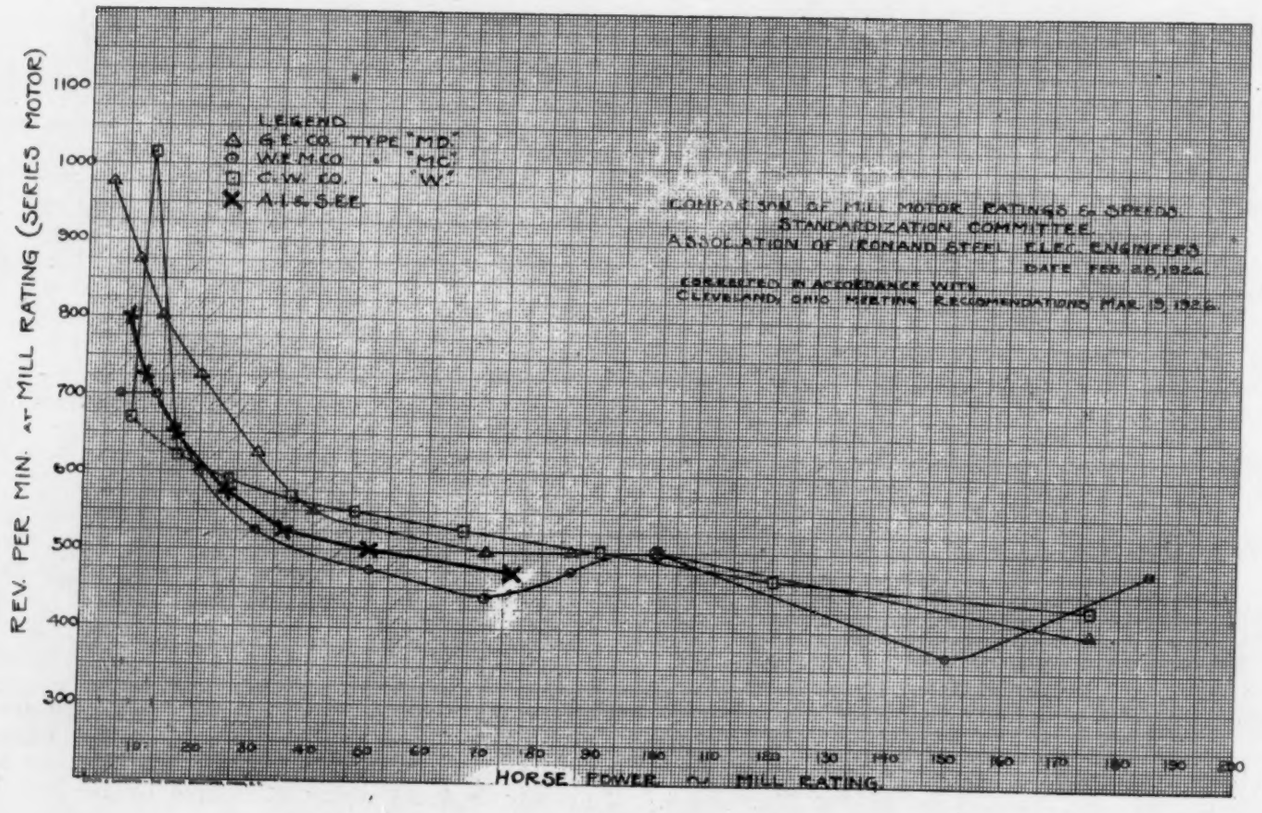

REV. PER MIN. AT MILL RATING (SERIES MOTOR)
LEGEND
G.E. CO. TYPE "MD."
W.E.M.CO. " "MC."
C.W. CO. " "W."
A.I.&S.E.E.
COMPARISON OF MILL MOTOR RATINGS & SPEEDS
STANDARDIZATION COMMITTEE
ASSOCIATION OF IRON AND STEEL ELEC. ENGINEERS
DATE FEB 28, 1926.
CORRECTED IN ACCORDANCE WITH
CLEVELAND, OHIO MEETING RECOMMENDATIONS MAR. 15, 1926.
HORSE POWER — MILL RATING

FIG. 5.

quently a single factor in a motor is the limit which prevents utilizing the other characteristics to the best advantage. It should also be understood that these motors will probably be so designed that when operated on a basis of their one hour rating, will have an actual temperature rise of nearly 75 degrees.

Figure 4 is a set of curves showing the relation of the ratings of the proposed motor to those now on the market, and will indicate the effort that was made to select ratings that were logical in respect to their relation with each other. The requirements of the crane builders were studied, and also the demands for the different sizes as recorded by the manufacturer's sales. Figure 5 similarly shows a comparison of the proposed speeds as compared to the speeds of similar motors now on the market. It may be of interest to note that the new motors will be lower in speed than either the Crocker Wheeler W, or General Electric MD 100 motors, and somewhat higher in the larger sizes than the Westinghouse MC motors. This increase in speed has been compensated for in back gear motors by increasing the standard gear reductions, and with two or three exceptions it will be possible to obtain

PROPOSED STANDARD MILL MOTOR DATA
STANDARDIZATION COMMITTEE A.I.&S.E.E.

	MILL RATING		CRANE RATING		TORQUE		DIAM. REQ. SHAFT AT BRG.	ANTI-FRICTION BRG. NO.	Bearing Number	Item Number
	H.P.	R.P.M.	H.P.	R.P.M.	MILL	CRANE				
FRAME A	7½	800	10	690	49	76	2.1654	311	216	313
" B	10	725	13	625	72	109	2.1654	311	218	315
" C	15	650	20	560	121	188	2.5591	313	220	317
" D	25	575	33	495	228	350	3.1496	316	222	319
" E	35	525	45	455	350	520	3.3465	317	224	320
" F	50	500	65	430	525	795	3.7402	319	226	321
" G	75	475	100	410	830	1280	4.3307	322	230	322

Note.—Maximum Axle Shaft Diameter reduced when 300 Series Bearings used.

FIG. 6.

lower speeds on the axle shaft than in any motors now on the market.

Frame Types

The new motors will be of the split frame type very similar to motors now on the market, except that the split in the frame will be from 1" to 1¼" above the center line of the armature shaft. This elevation of the split has been adopted for two purposes.

(1) In order to enable the Manufacturer to apply interpoles in the horizontal position and attach both interpole cores permanently to the lower half of the frame.

(2) To enable Manufacturers to elevate the center line of the axle shaft and thus secure a more rugged axle shaft bracket than is at present customary.

The openings for bearings in the ends of the frames will be enlarged as compared to the present type and the bearings will be installed in housings somewhat similar to those now used in box frame railway motors and also in the General Electric Co.'s Type CO, and Westinghouse Type K motors. The purpose of the changed design of the bearing housing has been to permit the installation of either anti-friction bearings or sleeve bearings at the option of the purchaser and to improve the sleeve type of bearings by eliminating the horizontal split in the bearing shell. It is felt by the Committee that this is a step forward in bearing design and it is hoped that it will meet with the approval of the users.

Bearings

The openings in the frame for the bearing housings will be of sufficient size to permit the installation of any of the standard anti-friction bearings whether of roller or ball type, and also the so-called "Sealed Sleeve" bearing. This will be accomplished by changing the machining of the housing. Thus the user may specify any type of bearing he prefers without otherwise affecting the interchangeability. Housings will be designed to be dirt proof. It will be possible, therefore, to store spare armatures and bearing housings, with bearing installed, in dirty places without fear of damage

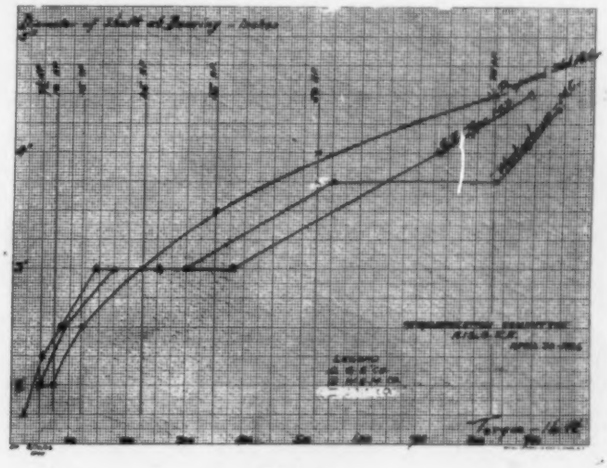


FIG. 7.

due to dirt and grit, and, if the user fills the housings with grease at the time of assembly, deterioration due to oxidation will be very unlikely.

The axle shaft brackets will be designed to accommodate either the sleeve type axle shaft bearings or the anti-friction type bearing. In order to secure the maximum axle shaft diameters it will be necessary to use the 200 series of bearings for axle shaft mounting. It of course follows that the 300 series can be used if the purchaser so desires, but the adoption of such a bearing will necessitate a reduction in the standard axle shaft sizes. On the other hand, if the users desire to increase the axle shaft diameter above that of the standard, it will be possible to do so by utilizing the sleeve type of bearing. Figure 6 is a table listing the H.P., torques, and anti-friction bearing sizes adopted by the Committee and approved by the bearing manufacturers attending the general meeting at the Convention in June. The aim of the Committee was to

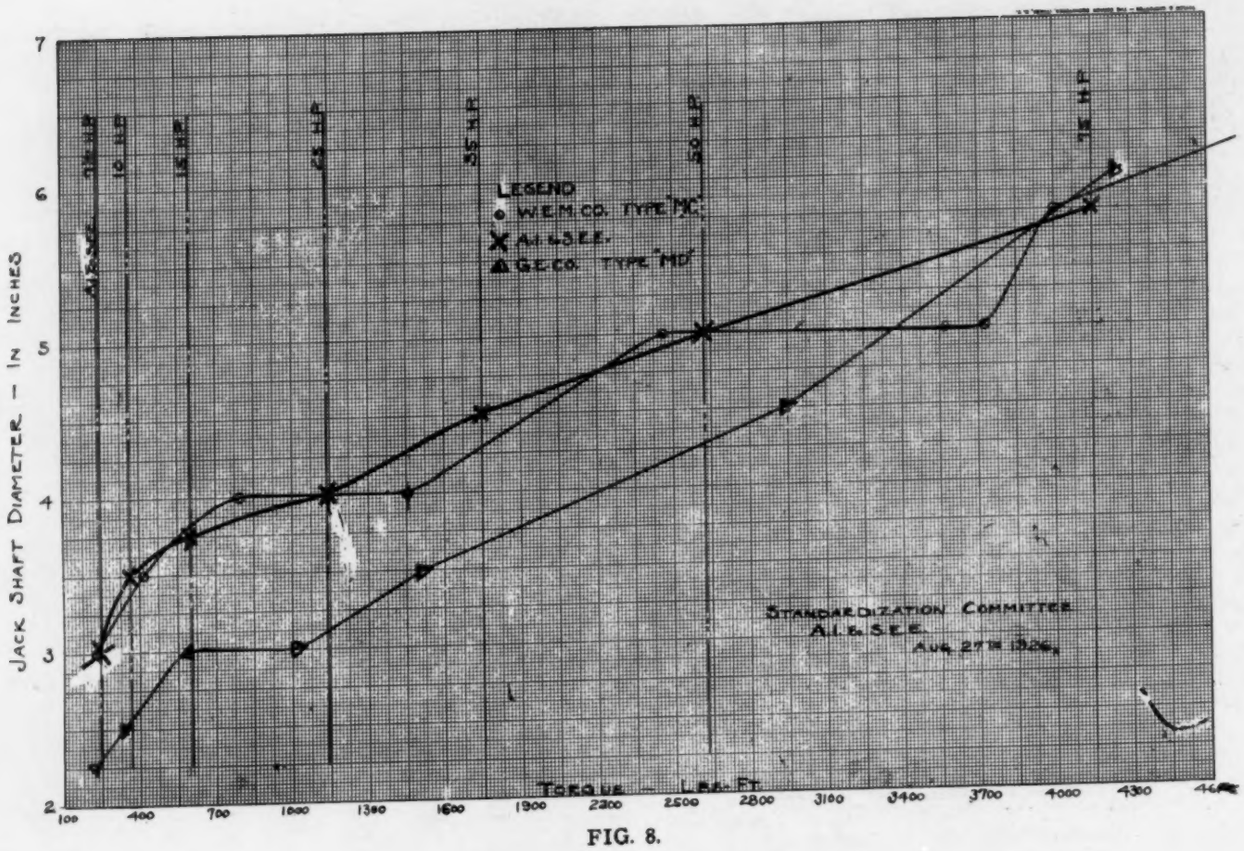

JACK SHAFT DIAMETER — IN INCHES
TORQUE — LBS.-FT.
LEGEND
W.E.M.CO. TYPE "MC"
A.I.&S.E.E.
G.E.CO. TYPE "MD"
STANDARDIZATION COMMITTEE
A.I.E.E.
AUG. 27TH 1926.

FIG. 8.

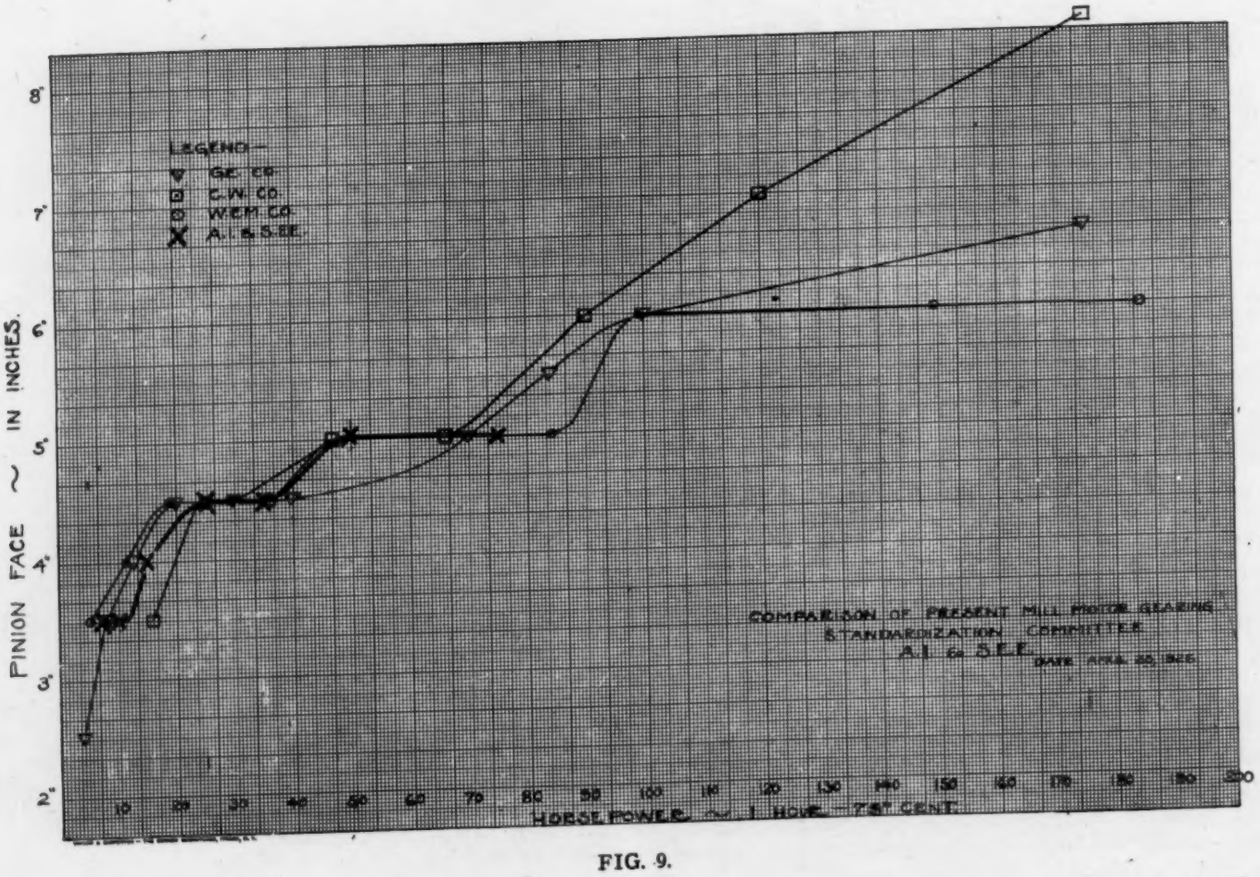
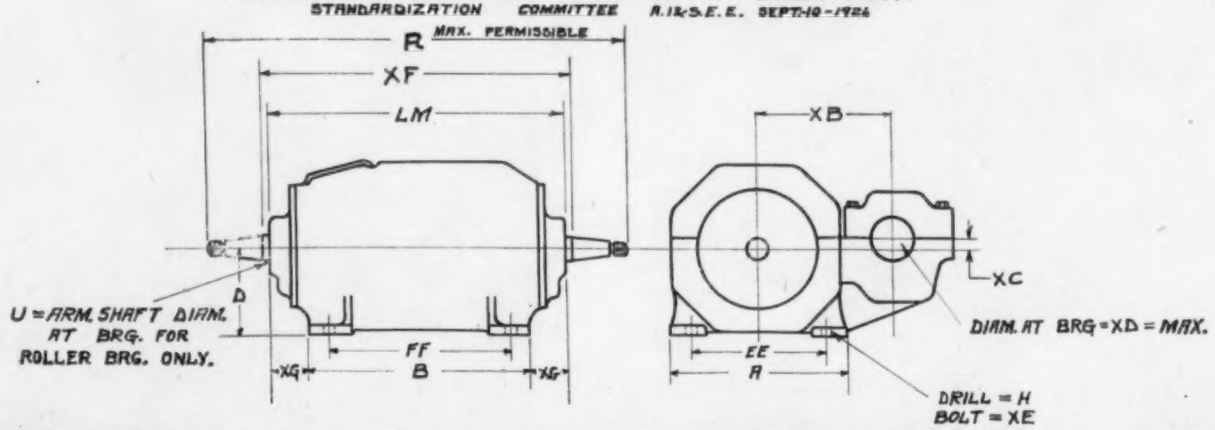

PINION FACE — IN INCHES.
LEGEND—
G.E. CO.
C.W. CO.
W.E.M. CO.
A.I.&S.E.E.
COMPARISON OF PRESENT MILL MOTOR GEARING
STANDARDIZATION COMMITTEE
A.I.E.E.
HORSE POWER

FIG. 9.

RECOMMENDED INTERPOLE MILL MOTOR DIMENSIONS

STANDARDIZATION COMMITTEE A.I.&S.E.E. SEPT-10-1926



FRAME NO.	RATING & SPEED + MILL HP.	+ MILL RPM	‡ CRANE HP.	‡ CRANE RPM	TORQUE LB. FT. MILL	TORQUE LB. FT. CRANE	GEAR RATIO *STD.	OVERALL DIMENSIONS IN INCHES EE	A	FF	B	D	XB	LM	XF	R	PINION PACE	PINION PITCH	ARM. SHAFT KEY WIDTH	ARM. SHAFT KEY HEIGHT	AXLE SHAFT KEY WIDTH	AXLE SHAFT KEY HEIGHT	H	XE	XD	U	XG	XC	FRAME NO.
A	7½	800	10	690	49	‡ 76	4.94	14	17	18	21	8½	12.625	29	30	39¼	3½	4	½	½	¾	½	29/32	⅞	3	2.1654	4	1	A
B	10	725	13	625	72	109	4.94	15	18	19	22	9	13.375	31	32	41¼	3½	4	½	½	¾	½	29/32	⅞	3½	2.1654	4½	1	B
C	15	650	20	560	121	188	5.05	16½	20	21	24½	10	14.375	34	35	45¼	4	4	½	½	1	¾	1 1/32	1	3¾	2.5591	4¾	1⅛	C
D	25	575	33	495	228	350	4.94	18¾	22¾	24¾	28½	11¼	16.833	39	40	51½	4½	3	¾	½	1	¾	1 3/16	1⅛	4	3.1496	5¼	1⅛	D
E	35	525	45	455	350	520	4.94	20½	24½	26	30½	12¼	17.833	42½	43½	55½	4½	3	¾	½	1	¾	1 3/16	1⅛	4½	3.3465	6	1⅛	E
F	50	500	65	430	525	795	5.05	22½	27	28½	33	13⅜	19.166	47	48	61	5	3	¾	½	1¼	⅞	1 5/16	1¼	5	3.7402	7	1¼	F
G	75	475	100	410	830	1280	5.05	25	30	32	37½	14¾	21.800	52½	53½	66¾	5	2½	1	¾	1½	1	1 3/16	1½	5¾	4.3307	7½	1¼	G

FIG. 10.

CONTINUED

FRAME NO	DIA. LARGE END OF PINION	DIA. GEAR HUB EXTEN	ANTI-FRICTION BRG. NO.	STANDARD GEAR RATIOS PINION	GEAR	PITCH	GEAR CASE BELOW BASE	AXLE SHAFT DETAILS HYATT	ALL OTHERS	FRAME NO
A	2	5	311	17	84	4	Δ 2½	W-216	313	A
B	2	5½	311	18	89	4	2⅝	W-218	315	B
C	2½	6	313	19	96	4	2¾	W-220	317	C
D	3	6½	316	17	84	3	3¼	W-222	319	D
E	3¼	7	317	18	89	3	3	W-224	320	E
F	3⅜	8	319	19	96	3	3	W-226	321	F
G	4¼	8¾	322	18	91	2½	4¼	W-230	#322	G

NOTES.

+ MILL RATING (BASIC RATING) 1 HR. CONTINUOUS RUN TEMP. = 75°C.

‡ CRANE " (APPROX. ONLY) ½ " " " " = " .

STANDARD SHAFT TAPER = 1.25" PER. FOOT. STANDARD SHAFT NUTS = 8 THREADS PER INCH.

* STD. IS MAX. Δ = LIMITING DIMENSION.

KEYWAY TO BE CUT PARALLEL TO TAPER - CUTTER TO BE RUN OUT.

ADDITIONAL AXLE SHAFT DETAILS TO BE DECIDED LATER....

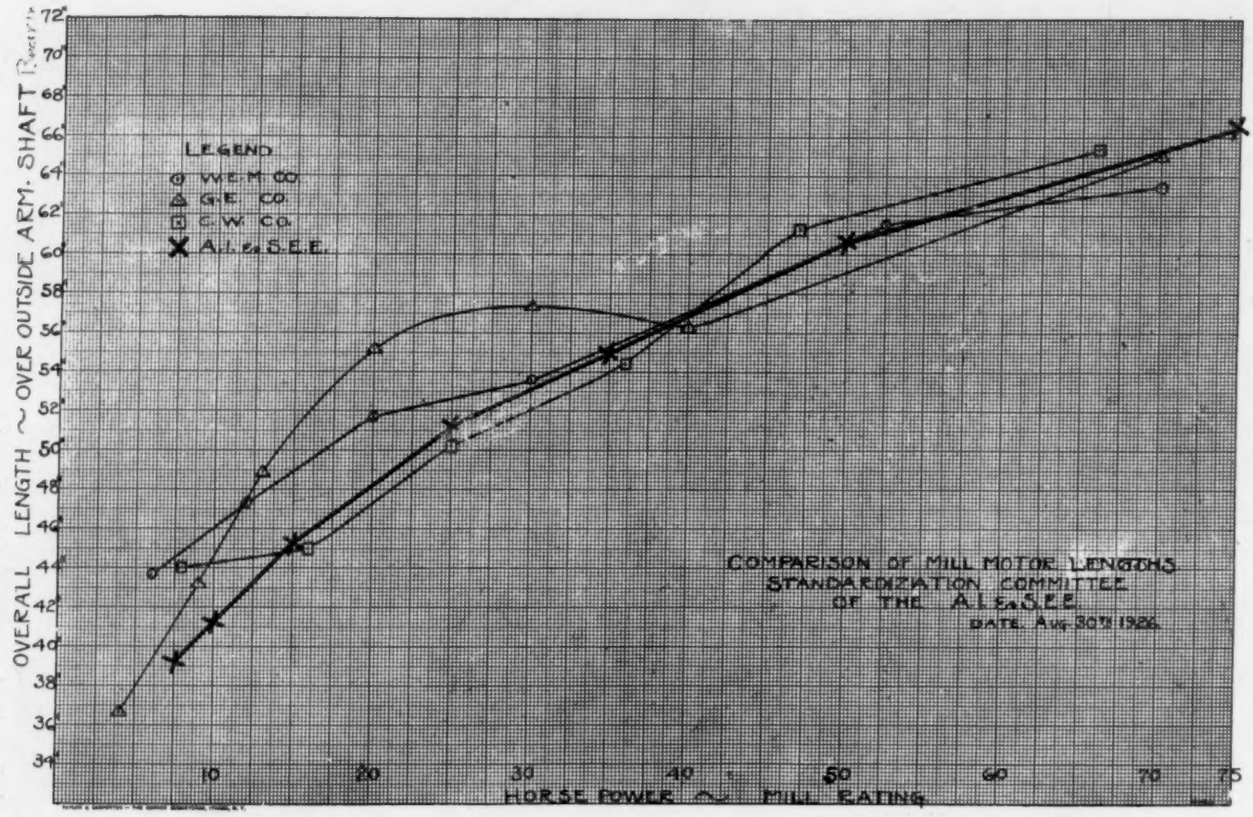


FIG. 11.

secure bearings of such capacity that 40,000 hours' life could be expected. While all of the bearing manufacturers were not willing to predict 40,000 hours' life, the majority did so.

Figure 7 is a set of curves showing the relation between armature shaft diameters at the bearing compared to the armature shaft diameters in current use. On the two smaller sizes this dimension is less than the General Electric MD, and Westinghouse MC motors. However, an investigation of the stresses in the shafts of these three smaller sizes disclosed the factors of safety in present designs to be greater than necessary, and from what service records are available, it was considered safe to reduce these shaft sizes to meet a uniform factor of safety of ten to twelve when based on combination of torque and bending moment using expected crane rating torque as a basis of loading. Similarly Fig. 8 shows a comparison of axle shaft diameters with those now used in the existing lines of motors, indicating that the sizes adopted are at least as liberal as those in current use.

Figure 8 is a comparison of the recommended axle shaft diameters with those now used in Westinghouse MC and General Electric MD Mill Type Motors.

Windings

New motors will be available in the series wound, compound wound, and shunt wound types. The standardized ratings are all based on series windings. The frames are to be made sufficiently large to accommodate a compound field winding which will limit the no load speed to approximately 50% above the full load speed. It is expected that the shunt wound speed will be not over 15% above the full load series speed. It was not feasible to design a shunt winding in a totally enclosed frame which would permit continuous operation across the line. It was therefore decided that forced ventilation would be acceptable, if shunt windings were specified.

Insulation

The manufacturers feel that they will be able to furnish a motor having a higher factor of safety in the insulation of both the armature and fields than in the motors now on the market. It is expected that the new motor will have incorporated improvements in the application of high grade insulating material.

Gearing

An inspection of the general dimension sheet, Figure 10, shows that the gear ratios are somewhat higher than now available. This change should appeal to those desiring to apply motors for crane and hoist work. Figure 9 shows the relation of the pinion and gear faces in the new motor as compared to that in the existing designs and indicates that in a general way existing pinion dimensions have been duplicated. Reference to the general table of dimensions, Fig. 10, will give the reader detailed data on the keys, gear pitches and gear dimensions adopted. The Power Club standards were adopted in selecting key sizes although in one or two in-

stances it was felt that the next larger size in the Power Club Standards should be adopted and therefore on a H.P. rating basis these standards are not strictly in accordance with the Power Club recommendations.

Dimensions

Figure 10 lists the complete recommended standardized interpole mill type motor dimensions which are a result of the study of the Committee. In selecting these dimensions, it was found that there were two factors which were of paramount importance in reaching an agreement among the different designers, viz., armature center line heighth above base, and the overall length over bearing housings. Figure 11 shows a comparison of the overall length over bearing housings of the new motor and existing designs. It will be noted that the new motor is somewhat longer than the Crocker Wheeler W motors and somewhat shorter than the General Electric MD, and Westinghouse MC motors. Figure 12 shows a comparison of the motor width, without axle shaft brackets, as compared to the types now on the market. Above 35 H P., the new motor is slightly wider than Crocker Wheeler W, and General Electric MD, while in sizes ranging from 10 to 35 H.P. it is narrower. In general it may be said that the motor occupies less space than now required and we believe that the user should in the majority of instances be able to substitute the new motor in the space now occupied by the Crocker Wheeler W, General Electric MD, or Westinghouse MC motors.

Figure 13 is a set of curves showing the relation of the armature center line above base plotted in terms of the cube root of the torque. It is generally accepted among designing engineers that types of motors having similar characteristics but differing in size should have armature diameters, bearing a definite relation to each other and it has been found that the heighth of armature center line above base is on an approximately straight line curve when the values of armature heighth are plotted in terms of the cube root of the torque, if the designs are all logical. We are submitting Figure 13 showing this relation on the new line of motors as compared to the existing designs to demonstrate that the dimensions recommended should permit designing engineers to develop what might be termed a logical line of motors, giving equally satisfactory service characteristics on every size regardless of rating. Figure 14 is a detailed comparison of the dimensions of the standardized commutating pole motor set up against similar dimensions on existing motors. By this table, the reader may definitely determine whether standardized motors may be substituted for existing motors on present installations.

The Standardization Committee was not successful in arriving at a set of dimensions which would permit the manufacture of both commutating and noncommutating pole motors having corresponding performance characteristics. The studies of the Committee lead to the conclusion that there were physical limitations in the design of each of these two types of motors which prevented selecting a set of dimensions which would meet the requirements of both without proving a handicap, and the probable result would be to increase the cost to the user.

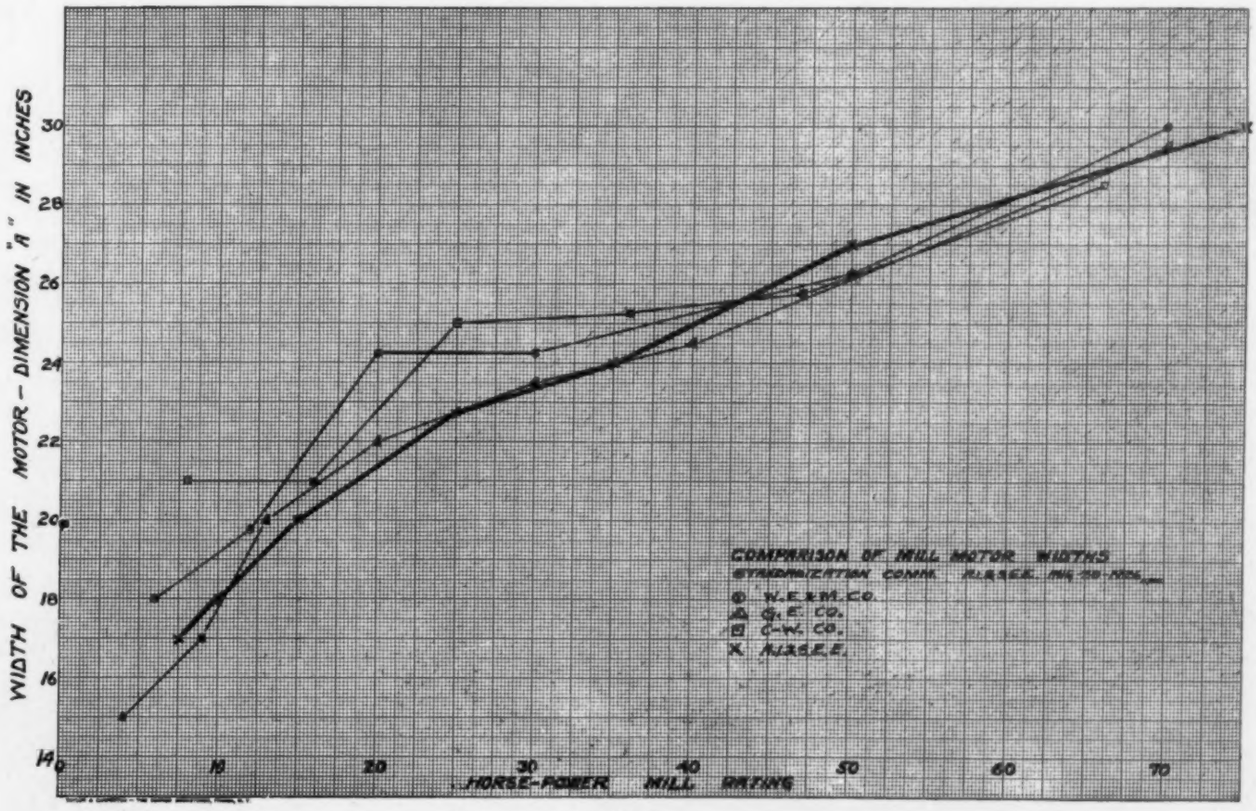


FIG. 12.

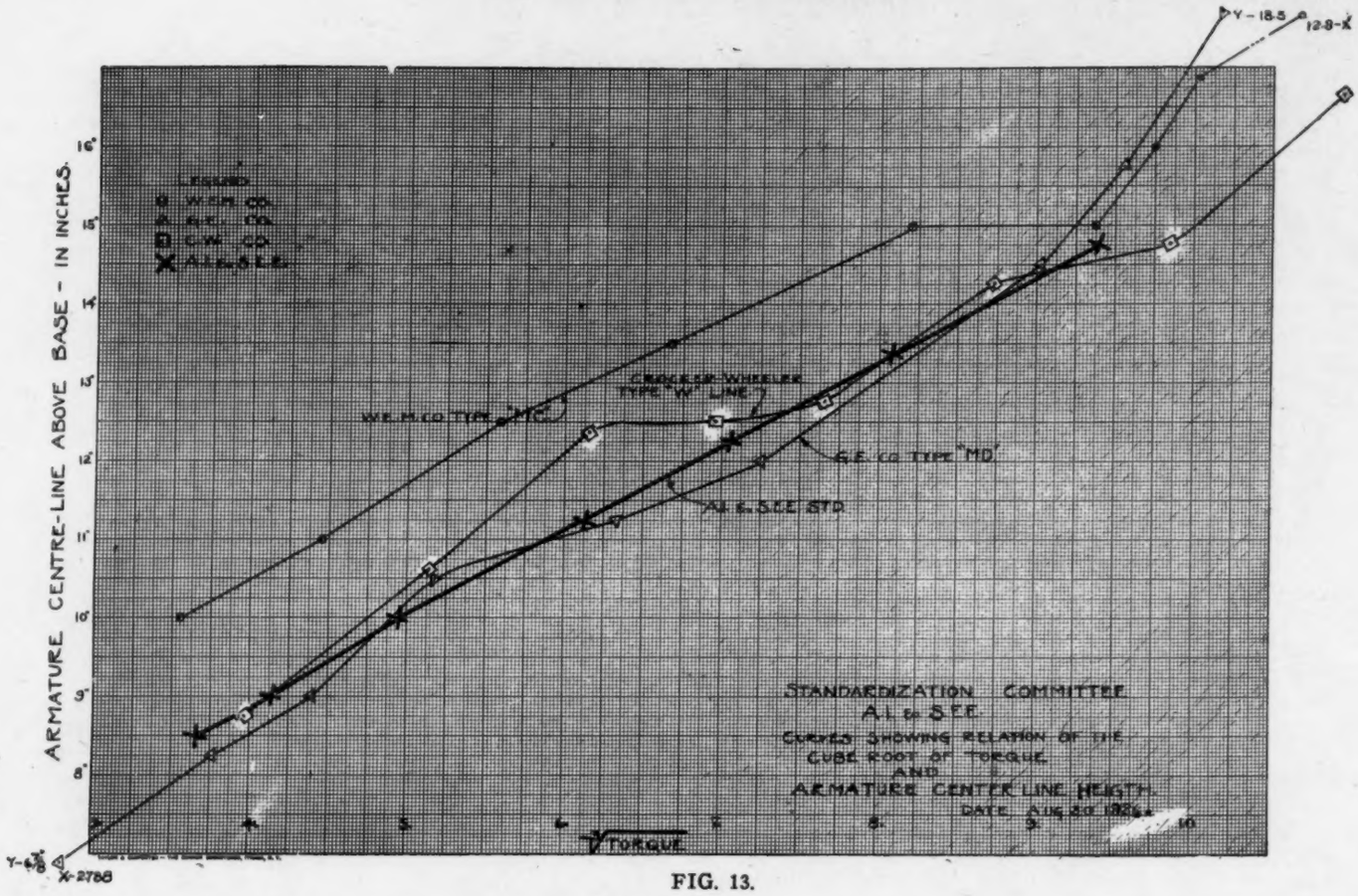
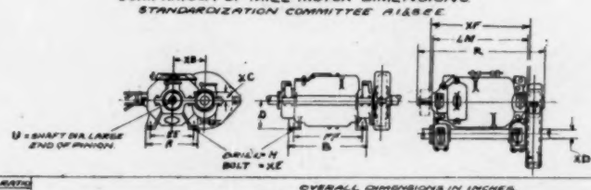


FIG. 13.

COMPARISON OF MILL MOTOR DIMENSIONS
STANDARDIZATION COMMITTEE A.I.E.E.



NAME OF MOTOR	TYPE	RATINGS & SPEED: 1 HOUR H.P.	1 HOUR R.P.M.	CONTINUOUS H.P.	CONTINUOUS R.P.M.	TORQUE LB-FT.	GEAR RATIO: MAX.	MIN.	OVERALL DIMENSIONS IN INCHES: EE	R	FF	B	D	XB	LM	XF	R	PINION: FACE	PITCH	KEY SIDEWAYS: WIDTH	HEIGHT	H	XE	XD	SHAFT DIA. LARGE END OF PINION U	AXLE SHAFT ROLLER BEARING: 200 SERIES	300 SERIES	XC
WEST	MC20	6	700	7½	600	44	14:70	58:86	7⅞	18	21¾	24⅝	10	10½	33⅜	33⅞	43¼	3½	4	½	3/16	10/16	⅜	3	2			0
G.E. (SL)	101	4	975	5	825	23	14:64		6½	15	16½	18½	6½	10	36¾	37	36¾	2⅞	4	3/8	3/16	7/16	⅜	1¾	1¾			0
C-W	A.W	8	670	10	570	63	17:97		9½	21	13⅛	17⅜	8⅜	11.4	29⅛	30⅛	44	3	5	½	3/16	1⅛	⅛	2½	2			
A.I.E.E.	A	7½	880	10	690	49	17:84		14	17	18	21	8½	12.625	29	30	39½	3½	4	½	½	5/8	7/16	3	2	2¼	3¼	1
WEST	MC30	12	700	15	600	88	15:69		8⅝	19⅜	26	29½	11	12	36	36½	47⅜	4	3½	5/8	9/32	11/16	⅝	3½	2½			0
G.E. (SL)	102	9	875	12	725	54	19:77		7½	17	17½	21	8½	12	43¼	43¾	43¼	3⅞	4	½	¼	9/16	⅜	2½	2¼			0
C-W	A2W	11	1015	13	910	60																						
A.I.E.E.	B	10	725	13	625	72	18:89		15	18	19	22	9	13.375	31	32	41¼	3½	4	½	½	5/8	⅜	3½	2	2.18	3.11	1
WEST																												
G.E. (SL)	103	13	800	17	700	85	21:83		8½	20	20	24	9	13	48⅞	49⅞	48⅜	4⅝	4	½	¼	25/32	⅜	2½	2½			0
C-W	BW	16	620	20	540	135	14:70		9½	21	17½	30	10⅜	14	32¾	33½	45	3½	4	5/8	3/16	1⅛	⅛	3				0
A.I.E.E.	C	15	650	20	560	121	19:96		16¼	20	21	24½	10	14.375	34	35	49½	4	4	½	½	1/32	1	3½	2½	2.20	3.13	1⅛
WEST	MC40	20	600	27	470	160	15:66	30:91	10½	24½	30⅜	33⅜	12½	13½	39¼	39¾	51⅞	4½	3	5/8	¼	1/16	1	4	3			0
G.E. (SL)	104	20	725	30	575	146	24:96		9½	22	24	28½	10½	15	55⅛	56⅛	55⅛	5⅞	4	¾	3/8	1/64	1	3	3			0
C-W	CW	25	595	30	540	225	16:82		11	25	29 1/16	32 1/16	12⅞	16⅝	35 1/16	37 1/16	50⅛	4½	3	¾	¼	1½	½	3⅜				0
A.I.E.E.	D	25	575	33	495	228	17:84		10⅜	22⅞	24¾	28½	11¼	16.833	39	40	51½	4½	3	¾	½	1⅝	⅝	4	3	2.22	3.19	1⅝
WEST	MC50	30	525	37	465	300	15:73	30:58	10⅝	24½	30¼	33⅜	13½	14⅝	41⅛	41⅞	53⅞	4½	3	5/8	¼	1/16	1	4	3			0
G.E. (SL)	104½	30	625	45	500	234	19:77		10¼	23½	25	31	11¼	16	57⅜	58⅞	57⅞	5⅞	3	¾	3/8	1/64	1	3	3			0
C-W	DW	36	565	45	500	340	18:82		11½	25½	34⅜	37⅜	12½	16⅜	40⅞	41⅞	54⅜	4½	3	¾	¼	1½	½	3⅜				0
A.I.E.E.	E	35	525	45	455	350	18:89		20½	24	26	30½	12½	17.833	42½	43½	55½	4½	3	¾	½	1⅝	⅝	4½	3½	2.24	3.17	1⅝
WEST	MC60	50	975	65	825	520	15:80	34:62	11	26½	30½	39	15	16⅝	47	47⅞	60½	5	3	7/8	5/16	1⅝	1½	5	3¾			0
G.E. (SL)	105	40	850	50	675	384	17:73		11	24½	25½	31½	12	15	56⅛	58¼	56½	5¾	3	¾	3/8	1⅛	⅛	3½	3			0
C-W	EW	47	590	60	490	450	19:87		11⅜	25⅞	28	31	12⅞	17⅝	45	46¾	61½	5	3	1	3/8	1½	½	4½				0
A.I.E.E.	F	50	500	65	430	525	19:96		12½	27	28½	33	13⅜	19.166	47	48	61	5	3	¾	½	1⅝	½	5	3½	2.26	3.21	1⅝
WEST	MC75	70	940	87	800	800	15:80	34:62	12½	30	37½	41⅜	15	16⅝	49	49⅛	63½	5	3	3/8	5/16	1⅝	1½	5	3¾			0
G.E. (SL)	106	70	800	85	660	760	17:73		12½	29½	27	33½	14½	18	65	67	65	4⅞	2½	1	⅛	1⅛	1½	4½	4			0
C-W	FW	66	525	85	470	640	18:78		12½	28½	41⅛	45⅛	14½	19⅝	48⅛	50⅞	65⅜	5	2½	1	3/8	1⅜	1⅜	4⅜				0
A.I.E.E.	G	75	475	100	410	830	18:91		25	30	32	37½	14½	21.800	52½	53½	66¾	5	2½	1	½	1⅝	1⅝	5⅛	4½	2.30	3.22	1½

FIG. 14.

At the present time the Committee is informed that the General Electric Co. is the only Company contemplating the manufacture of the standardized motor in the near future. However, the Committee has the assurance of both the Crocker Wheeler and Westinghouse Co.'s that if it is found that there is a demand for new designs of commutating pole mill type motors among their customers such commutating pole motors will be built to the Association's Standardized Dimensions.

The Crocker Wheeler Co. is the only manufacturer now marketing the non-commutating pol mill type motor. The Committee has therefore not deemed it necessary to provide standardized dimensions for non-commutating pole motors as there is no immediate prospect of any re-design of this type of motor. However, the Committee does not wish to convey the impression that it is expressing a preference for either commutating pole or non-commutating pole mill type motors for steel mill duty. The Crocker Wheeler Co. has assured the Committee that should any changes affecting the external dimensions of their non-commutating pole motor be contemplated they will notify the Association in order that a set of logical non-commutating pole dimensions may be worked out similar to the program just being concluded for the commutating pole mill type motors.

The Committee will request all other manufacturers to similarly notify the Association in case they contemplate developing new designs of non-commutating pole mill type motors for steel mill service.

In conclusion the Chairman wishes to take this opportunity to thank the engineers of the Pawling & Harnischfeger Corp., Allis-Chalmers Mfg. Co., Reliance Elect. & Engineering Co., the Electro-Dynamic Co., the Westinghouse Elect. & Mfg. Co., General Electric Co., and Crocker Wheeler Elect. Mfg. Co. for the splendid co-operation they have given the Association in this work. The interval between meetings was short, and the amount of data these gentlemen presented required careful and concentrated attention during the entire period of the Committee's activities. We feel they have rendered a service of definite value to the entire steel industry. The Chairman also wishes to thank the active members of the Association who gave him the benefit of their advice and assisted in preparing data for the work of the Committee. Among those who were generous with their time were W. S. Hall of the Illinois Steel Co., R. S. Shoemaker of the American Rolling Mill Co., W. T. Snyder of the National Tube Co., E. S. Jeffries of the Steel Company of Canada, A. G. Place of the Youngstown Sheet & Tube Co., R. H. Keil of the Jones & Laughlin Steel Corp., J. E. Fries of the Tennessee Coal, Iron, and R. R. Co., Jas. Farrington of the Wheeling Steel Corp., D. M. Petty and A. J. Standing of the Bethlehem Steel Corp., J. M. Hipple, Westinghouse Elect. & Mfg. Co, Brent Wiley, Westinghouse Elect. & Mfg. Co., R. W. Owens, Westinghouse Elect. & Mfg. Co., B. M. McCusker, Westinghouse Elect. & Mfg. Co., C. W. Lange, General Electric Co., J. D. Wright, General Electric Co., J. C. Barry, General Electric Co., A. C. Bunker, Crocker-Wheeler Elect. Mfg. Co., J. R. Lewis, Crocker Wheeler Elect. Mfg. Co., C. A. Mudge, Electro-Dynamic Co., Arthur Keller, Pawling & Harnischfeger Corp., A. M. McCutcheon, Reliance Elect. & Eng. Co., J. R. Jeffrey, Allis Chalmers Mfg. Co.

Manipulators For Blooming Mills *

By L. IVERSON†

THE ideal manipulator is one which can perform the required operations of pushing, turning and grasping the ingot or bloom, in a minimum of time, with the least attention for upkeep and repairs. The problem of manipulator design, therefore, is to approach these features as closely as possible. It is a problem requiring years of practical research and patient, diligent study.

In this paper is pointed out, in a general way, the solution of the problem as it has been accomplished by the Mesta Machine Company.

It will be seen at once that speed is by far the most important element in manipulation, since the time spent by the ingot at the manipulator is unproductive and, therefore, time lost. Only that time which the ingot spends in the rolls is actually productive. The ideal manipulator should be able to catch the ingot at the very instant it leaves the rolls, stop it, and place it in position for the next pass by the time the mill has reversed. The closer the machine approaches this condition, the closer it has approached the ideal.

Speed in operation is probably the most outstanding feature of our Patented Manipulator. This feature has been brought about by approaching the design problem from an entirely new view point, the chief feature of which is a reduction in the mass required to be moved in tilting the ingot, together with the use of a minimum of moving parts.

The tilting fingers of our Manipulator move independently of the side guards, both the tilting fingers and side guards being operated by a separate motor. The tilting fingers are mounted on a flexible shaft which eliminates all possibility of binding in the bearings, due to warping of the

*Presented before Pittsburgh District Section.

†Vice Pres., Mesta Machine Co., West Homestead, Pa.

side guards, and insures smooth operation at all times. Proper gearing and power proportion gives the operator complete control over the machine at any stage of its operation. Protection of the electrical parts against overloads has been made by the design as above described, whereby binding and sticking is almost impossible.

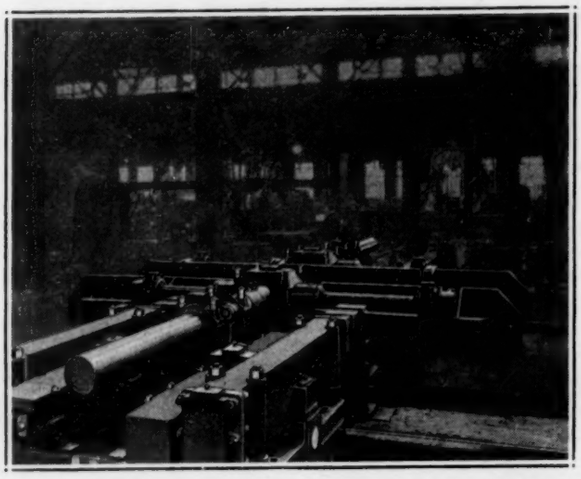


FIG. 1—Hydraulic Manipulator 40" Blooming Mill

In accomplishing this quick action of operation no compromise has been made with the necessarily heavy weight of the parts. As a rule, the presence of mass is a very good thing in rolling mill machinery because it takes up impact forces and is an insurance against the trouble caused by unforeseen contingencies. In manipulators, however, excessive

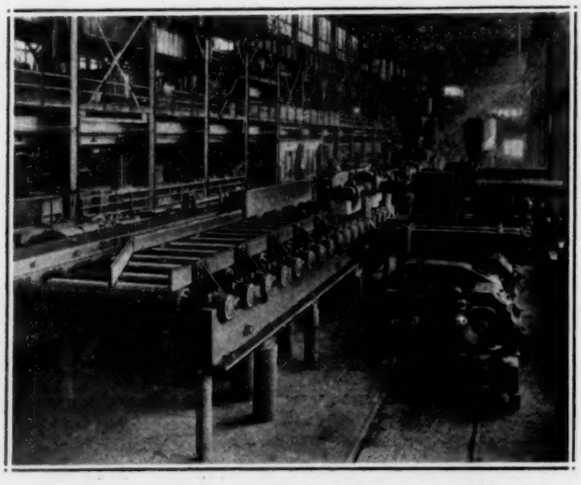


FIG. 2—36" Blooming Mill Manipulator

mass in the moving parts is a genuine fault and can only be overcome by careful engineering. As has been described above, our design has solved the problem by reducing the mass to be lifted and the number of parts to be moved without sacrificing the extra heavy construction.

The second problem in manipulator design is that of producing a machine so capable of meeting the severe service to which it is subjected that the least possible time is lost in upkeep and repairs. The necessity of having sufficiently heavy construction is obvious. The questions of inspection, lubrication, and replacing of naturally worn out parts is fully as important.

Even if a manipulator be such that it reduces the idle time between passes, yet it would not be ideal if it caused loss of time during periods of inspection and repair. Table rollers and their bearings must be inspected and replaced from time to time. If the manipulator covers these bearings at all times and makes access to them difficult, inspection will be either infrequent or wholly absent and incipient trouble is not noticed. Our design permits the manipulator to be moved entirely off the table, exposing the table rollers and bearings for inspection and repairs, providing an insurance

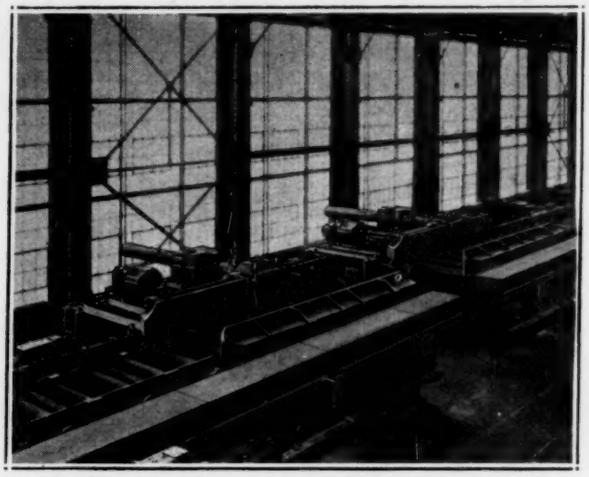


FIG. 3—Electric Manipulator 36" Blooming Mill

against breakdowns, and making quick repairs possible.

Because of the scale produced in all mills it is well to locate all manipulator parts above the table to prevent scale from dropping on them. While the proper location helps, it is by no means a guarantee that scale cannot reach bearings and sliding parts. As steel passes through the main rolls, the water on the rolls evaporates and shoots powdered scale into the air. This fine scale covers all objects within the mill building and will get into the bearings regardless of location unless guarded against otherwise. For this reason slides and bearings in manipulators should be provided with covers, keeping out the scale and insuring longer life. Total enclosure of all parts has two additional advantages: It makes for safety and it encourages automatic lubrication. These features are embodied in our Manipulators. All gears, shafts and moving parts are completely enclosed and run in oil.

The question of hydraulically operated or electrically operated manipulators is a question involving many considerations, chief of which seems to be the preference of operating officials. While the majority of recent manipulator installations have been made with electric drives, there have also been some notable hydraulic installations. Our design is very well adapted to either hydraulic or electric operation.

With competition increasingly keen as it is in the rolling mill industry, it is imperative that mills become more and more productive if they are to operate successfully. Although much has been accomplished by operators during the last decade in the way of mill development, little has been done to bring present equipment up to maximum efficiency. The majority of old mills are operating just as they were installed.

It has been definitely proved by past performances that installations of modern manipulators on old mills are capable of increasing tonnage output as high as 30%. An increase of even 5% in the tonnage output of an old mill would more than justify the purchase of necessary equipment. In view of these facts the installation of modern manipulators on old mills, which includes the majority of blooming mills in this country, is not only good practice—it is good management and a sound investment.

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*Manipulators For Two High Reversing Blooming Mill**

By C. J. KLEIN†

PRESENT day Manipulator practice seems to vary to some extent with the operators as well as with the product which is to be rolled. Of course, there is practically only one type of Manipulator which is built today and that has the power operated side guards and tilting fingers each controlled separately. There are various arrangements of installations which are determined by the product to be rolled, namely, side guards on one side of the mill only—usually on the entering side, or moving side guards on both sides of the mill. Tilting fingers on from one to three side guards. Usual practice is to have fingers on the entering side of mill, on one side guard only. These fingers must be designed to manipulate any section from a 4"x4" billet to a 26"x46" ingot or larger. The usual operation of reducing a 19"x22" ingot to a 4"x4" billet would be, two passes, turn; four passes, turn; four passes, turn; two passes, turn; four passes, turn; four passes, turn; and one true-up pass.

As can be readily appreciated, the design of the Manipulator must be such that there is practically no cause for a breakdown, or if such would occur, it could be readily fixed with the least possible delay. Having this in mind, Manipulators are designed with large factors of safety.

There has been a doubt in the minds of some engineers as to the necessity of the weight of the up-to-date Manipulator and whether it would not be possible to design lighter machines.

In going back to the earlier types of Manipulators, the "Bulldozer" was probably the simplest type of machine built, having two side guards and one tilting mechanism. This weighed approximately 38,000 pounds and was used in connection with small blooming mills starting with about a 3500-pound ingot. This type of Manipulator was not practical for rolling slabs and in the course of developments, the Manipulator of today, having four operating side guards and almost human in its operation, was developed. Machines of this design weigh as much as 1,200,000 pounds and handle ingots weighing as much as 40,000 pounds.

The weight of a "Bulldozer" Manipulator, having four side guards, would be about 70,000 pounds or twenty times the weight of the ingot. The weight of an up-to-date Manipulator runs about thirty times the weight of the ingot. Taking into account the larger stroke of the side guards, due to longer rolls, the more efficient manipulating mechanisms, the additional weight necessary to protect and enclose all moving parts where possible, it does not appear as though the weights have gone excessively high. Another important factor to be taken into account is the enormously increased tonnages produced today against twenty-five years ago.

Before going into the general design of up-to-date manipulators, it may be of interest to follow the developments of the Manipulator.

In July, 1879, D. C. Jones received a patent which formed the nucleus of a Manipulator design which has been built in a modified form as late as 1912. This Manipulator, called the "Bulldozer," consisted of 2 hydraulically operated side guards opposite each other, having plow shaped side guards. When the two side guards were run together, the material would tend to revolve, to facilitate this turning operation a hand operated set of fingers were mounted on each guard and were of such a design so that the material could be turned in either direction or not turned at all. The operating mechanism was entirely above the floor line and outside the tables. The side guards were carried on rollers which were supported on the table rollers.

In June, 1887, Mr. R. W. Bailey was issued a patent on lever-type Manipulator consisting of a series of levers hydraulically operated which carried the material back or forth on the table. These levers were so mounted that they could be raised and lowered, thereby using them for turning as well as traversing material. The operating cylinders were located outside of the tables.

J. Kennedy was issued a patent on a Manipulator in July, 1888, which was used extensively and was built as recently as 1912. This Manipulator

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*Presented before Pittsburgh District Section.

†Engr. Dept., United Engineering Foundry Co., Pittsburgh, Pa.

consisted mainly of a structural frame located underneath the table, mounted in two parallel lifting levers. The frame carried a number of vertical posts which were used for tilting or moving the material sideways. The frame was moved sideways by a hydraulically operated cylinder through connecting rods. The lift was accomplished through the levers which carried the frame, and connecting rods attached to a hydraulically operated cylinder. Manipulators of this type were not applicable to the edging of slabs, which was the main reason for Slabbing Mills in those days.

Modification of the vertical posts were made in several patents issued later, the one being adopted most was a fork arrangement which made the operation of the Manipulator more flexible. In November, 1898, S. V. Huber was issued a patent modifying the vertical posts so that slabs could be turned up on edge. This consisted of a hydraulically operated lever mounted in the vertical post. After the post was lifted and the slab reclined at about a 45 degree angle, the lever was operated thereby setting the slab on edge.

On February 19, 1903, J. Kennedy was issued another patent, similar to the one issued previously, but which had a hydraulically operated side guard in front of the edging passes only, for turning slabs on edge. The frame, vertical posts, etc., were operated in the same manner as previously stated.

On February 24, 1903, a patent was issued to C. H. Wellman, the design of which included the first individually operated side guards and tilting fingers. The first Manipulator of this type, which made it possible to turn or edge material on any part of the table, was built for the Grand Crossing Tack Company. Manipulators of this type were built as late as 1914 and many of them are still in operation. The side guards were operated hydraulically through cylinders, levers, racks and pinions. The racks and pinions were necessitated by the extra long side guards on both sides of the mill. The racks were carried in guides located underneath and outside of the tables. The tilting mechanism consisted of a frame attached to the racks and one side guard moving integrally with the side guard. A series of vertical posts, located between the table rollers, were operated hydraulically through a series of bell cranks and levers. The operating cylinder was located stationary outside the table, the operating shaft having a square extension running in the operating lever, having a square hole permitting the fingers to be tilted in any position.

On September 3, 1907, a patent was issued to J. Kennedy for an improved type of Manipulator having the same fundamental principles as the Wellman Manipulator, namely, individually operated side guards and tilting fingers, the principal change in design being the operation of the fingers. The last Manipulator of this type was built in 1920. While the patent drawings show this Manipulator hydraulically operated, it was next equipped with electrically operated tilting fingers and hydraulically operated side guards and later equipped entirely with motors. The finger operating mechanism of this Maniplator consisted of a series of bell cranks and levers mounted on the side guard operating racks, being connected to the driving motors through a universal coupled shaft, thereby allowing the fingers to be operated in any position of the side guards. Considerable operating mechanism of this type of Manipulator was located underneath the tables and also necessitated considerable changes in tables if it were to be installed in an existing table. This objection was overcome by a Manipulator, a patent of which was issued to J. Fawell of Mackintosh-Hemphill Company in March, 1909. This Manipulator was entirely outside the table and all the finger operating mechanism located above the elevation of the top of the table roller. There was a possible objection to this design inasmuch as the finger tilting cylinders were located on the moving rams, thereby necessitating the use of flexible hydraulic connections. To overcome the above objection, a new design of finger operating mechanism was patented on October 4, 1910. The side guards of this Manipulator were hydraulically operated through cylinder, levers and links; no racks and pinions being employed. The tilting of the material was accomplished by raising the entire side guard fingers and ram horizontally through a stationary hydraulically operated cylinder, bell cranks and levers. It may be noted that the principle of this Manipulator is now used extensively.

A patent of a modified form of Fawell Manipulator was issued to D. F. Nesbet in September, 1912. The principal departure in this design was the tilting of the side guard for manipulating the material instead of raising the entire head and rams horizontally. Several Manipulators of this type have been built and were usually confined to hydraulic operation.

A patent of a new design of Manipulator, having individually operated side guards and tilting fingers, was issued to Lane Johnson of the United Engineering & Foundry Company, of which three have been built to date; one for the Andrews Steel Company and two for the Carnegie Steel Company, Homestead Works—(one being used in connection with the largest Blooming Mill, having 54" pitch diameter pinions, which was also built and designed by "United"—and one used with the 44" Blooming Mill.) The tilting fingers are operated through a lever pivoted at the center and pulled down at the back end when material is to be tilted. This is the most logical way of doing this work as it is the same principle as a man using a crow bar. This type can be built with lifting side guards and fingers combined or lifting fingers only.

The demand for increased tonnage and more efficient operating conditions led the Andrews Steel Company of Newport, Ky., to order their Manipulator of up-to-date design. The old Manipulator was of the "Kennedy" type, hydraulically operated and located on one side of the mill only. The standard ingot used on this mill, which has 34" P. D. Pinions, is 19½" x 21½" x 7600 lbs.. and it is proposed to increase the pitch of the mill and use a 25½" x 25½" x 12,000 lbs. ingot for which the new Manipulator was designed.

Before designing a Manipulator, it is necessary to receive a certain amount of preliminary informa-

tion, the most important of which is the following: Building layout, as very often interferences are encountered in the way of building columns which will determine whether it is possible to place a Manipulator on each side of the table which allows of a simpler design or whether it is necessary to place all the operating mechanism on one side of the table. The next information necessary is whether a new or old table is to be accommodated. The size of ingot, minimum size of billet and maximum size of slab are also determining factors. The manipulation of the material will also determine whether tilting fingers are necessary on each side of the mill. As practically all manipulators are now built electrically, there are no alternatives in this case. The working length of the blooming mill roll will determine the stroke of the side guards.

After receiving the above information, the next important issues to decide are simplicity of design, accessibility for replacement of wearing parts, ease of operation, up-keep, and reliable lubrication.

The most radical departure from the "Kennedy" type of Manipulator in the operation of the side guards, was the elimination of racks and pinions, this being accomplished by levers and connecting rods, the front end of the rams being carried in guide stands, entirely free of the tables, and on segements cast integral with the levers on the rear. While this design increases the weight of the machine to some extent, due to the fact that the leverage of the arm is greater than on the rack pinion, the accessibility afforded thereby is well worth the extra cost. The next most important feature of up-to-date Manipulators is the finger operating drive which should be mounted stationary on the foundation. It may be noted that European practice in this respect is to mount the finger operating mechanism on the moving ram or on a separate base which travels with the rams.

The difficult feature in operating the fingers from a stationary drive is the fact that they must be operated with the side guard located at any working part of the mill rolls.

The ordinary practice for accomplishing this feature is the same as was first used on the Wellman Manipulator, namely, a square shaft sliding in a square nut.

In this respect, the design also differs in that a series of levers were used, thereby eliminating a considerable amount of lost motion caused by loose sliding fits.

While this Manipulator is designed so that fingers can be placed on two of the four side guards, at the present time there is but one set of fingers on the entering side of the mill.

The motors for this equipment are all duplicated. Two 100 H.P. motors, 475 R.P.M., compound wound, connected in series, running at 237 R.P.M. were used for each set of side guards. Two motors running in series were used for the tilting fingers. Brakes were used in connection with all motors. No limit switches were employed for limiting the stroke of the side guards as the small amount of clearance between the side guard supports and the table girders does not permit of sufficient overtravel. The operator must use his skill in this connection, the same as is necessary when the side guards come together between the girders. A 360° limit switch is provided for the tilting fingers as this is crank operated.

In actual operation, the horse-power readings on the above motors were a total of 166 H.P. for each set of side guards and 67 H.P. for the tilting fingers. As can be seen, the tilting finger motors were considerably under loaded, but considering the fact that all motors are alike, it appears to be the best arrangement on account of spares.

In a comparison of Manipulators at the Andrews Steel Company Plant, it was found that the new type Manipulator increased the tonnage about 25 per cent over the old hydraulically operated Manipulator.

The mill, which is engine driven, and the electrically operated mill tables and manipulator are controlled by three operators. One controls the Manipulators through three levers, one man controls the tables and mill screwdown, and one man runs the engine. Where the mill is electrically operated, only two operators are required as the motor is controlled by the roller.

Lubrication on Manipulators, as on all other machinery, must be well taken care of and to this end an automatic grease feeding mechanism was designed so that on each stroke of the side guards, a predetermined amount of grease is shot onto each sliding or rotating surface except the gear bearings, which are ring oiled. A central grease storage tank is all that needs replenishing for the automatic feeding device. All gears are entirely enclosed and run in a bath of oil.

DISCUSSION

L. C. Edgar*: In the competition of today it is vitally important that steel plants operate at as low cost as possible. In order to make that low cost possible, maximum production of a mill is vital. The manipulator enters into the production to a very marked degree. In the first place, it makes possible speedy operation of the mill, for regardless of how powerful or fast your rolls and accessories other than manipulator are, if your manipulator design is weak, you, of course, cannot maintain production. Therefore, speed is one of the important items of a manipulator and another is ease of operation upon which speed may depend to a large degree. Another important factor in production and cost is reliability.

I have a feeling that probably the earlier manipulators were hydraulic, partly because electric apparatus had not developed to the extent it has today and it would have been very hard to develop them along those lines. As electrical engineers developed they improved designs of the apparatus and there has been a swing towards electrical driven manipulators, thereby getting the first item, ease of operation and speed; and at the same time having also the second, that is, reliability.

Ease of repairs comes in with perfection in design, making it possible to make any changes that

*Chief Engineer, Carnegie Steel Co., Braddock, Pa.

may be necessary, and no one can be so perfect in his design or prevent accidents so completely that something won't happen to a manipulator any time. We always have our old friend, wear, and we have to change for that reason.

It is a vital subject and while I have had very little experience on manipulators and cannot speak with authority, I know it is an important subject and we should get some good discussion that will be for our mutual benefit.

Ira J. Simmons†: It has been my privilege to operate and maintain one of the earliest type of manipulator ever invented, also my good fortune to be in on the design, installation and operation of one of the most modern up-to-date machines in existence today.

When we decided to make the change, we found among other things, that it would necessarily have to be Hydraulic for a time at least, due to our already inadequate power supply. However the design is such that we can change to Electric drive with a minimum of delay and expense.

The upkeep has been quite nominal; we use something like fifteen pounds of cup grease per week. We have changed a few places from gravity oil feed to pressure grease lubrication.

I would call your attention to the fact that we insisted upon having a manipulator with every moving part above floor level; this has worked out very satisfactory. We also insisted upon speed, and we got it, in fact, we had so much speed that in order for the operator's mind and motion to keep pace with the machine, we found it necessary to reduce to 5/8" the opening in our 1½" lines, and with this arrangement we have rolled in 25 minutes—28 Ingots 20 x 22 to 8 x 6½ and 900 Ton in 8 Hours, 2300 Ton in 22 Hours 35 Minutes' operating time in 24 Hours. This 2300 Tons however was reduced to a cross section of 8 x 5".

Reference has already been made here this evening to the speed of motor driven mills, etc., and it would be very interesting to us after 25 years' experience with steam on a high speed mill to know just how fast one can expect a motor driven mill to be or just how "snappy" it really is. I am of the opinion that we have approached very closely the ultimate in speed on maniplators, and for any additional improvement, I suspect we will have to depend upon the motor to show some speed if we hope to approach or better the tonnage records set up by our steam driven units.

Up to this time we have rolled approximately 800,000 tons since installing our new manipulator, and so far it has proven eminently satisfactory.

We feel particularly pleased with it perhaps, due to the fact that we have lived to see several of our own pet ideas worked out in connection with it; and best of all, to see it do what we had hoped it would do.

In passing would like to add that the demonstration here this evening would tend to prove that the art of handling large masses of metal at will has certainly kept pace with the advancement in all other lines.

†28" and 40" Mill Supt., Carnegie Steel Co., Clairton, Pa.

G. E. Stolz*: Mr. Iverson raised one question, whether electric driven manipulators were as good or better than hydraulic. The hydraulic has certain inherent advantages and was used in the past simply because the electric was not developed. When the ingot is being hugged by side guards it is only necessary to have continued pressure against the piston. If a motor is geared to these side guards and two guards are brought against the ingot, the motor would take a very large amount of power which would burn it out if continued. To obtain the same effect in that instance as the hydraulic, the control should be designed with permanent resistance in series to limit current to about 200 per cent of rated value. That means instead of gearing the motor for its normal full load speed it should be geared for a lower speed, or on the basis of reduced voltage. In attempting to operate at reduced speed, the capacity of the motor should be increased to compensate for this reduction in voltage to get the same effect as if there were no permanent resistance in series. In this way the equivalent of hydraulic drive is obtained and one will still have the advantage of electric drive.

I happened to make a test on one of the fingers of one of the mills shown in a slide. When the mill was installed the fingers were operated by a mill type compound motor. This type of motor has very small proportion of shunt winding. It was found when the fingers did not catch the ingot, the motor would overspeed and severely rack the whole mechanism. The winding was changed to give the motor shunt characteristics and the speed of fingers were about the same whether fingers were lifting the ingot or going through the cycle idle. So that I think the advantages that hydraulic does have can be obtained by proper study of these applications.

There is no question but what some progress has been made in the design of side guards and fingers. That is readily seen by the slides shown. It is a difficult problem. I imagine the most difficult problem in designing a blooming mill, is to obtain proper manipulation. One thing has been accomplished, not only on the manipulators, but on other parts of the mill is the use of cut gears running in oil and the alignment of the apparatus so as to prevent flexing of parts. In former days we used to apply these motors using a factor of two to three times normal rating, and there were times when that was required; but today with improved design, where we can prevent misalignment, the rating of a motor can be reduced to a size that is commensurate with the mill design. This has some advantages other than first cost. Practically all operations require rapid acceleration. The matter of getting this equipment started or of completing the cycle is just a matter of a second or two. A motor with large fly wheel effect, takes excessive amount of power from the line. So by reducing the capacity of the motor the cycle of operation is really much easier to accomplish.

At our meetings ten years ago, the question was discussed whether a big reversing motor could reverse in short enough time to make it practical for

*General Engineer, Westinghouse E. & M. Co., East Pittsburgh, Pa.

a blooming mill. That I think has been worked out satisfactorily, but a considerable investment is made in a big blooming mill, and in general, I think you will find from one-third to one-half the time is required for manipulation. That is, if it takes one minute to roll an ingot only 30 seconds of that time the metal will be in the rolls. While a lot of progress has been made in speeding up manipulators this subject can still be given considerable study.

J. S. Green†: I realize today that dreams come true. Several years ago, back in 1900 to 1905, I was with the Carnegie Steel Company, as millwright foreman, and one of my duties was to take care of one of the old Kennedy type of manipulators, and believe me it was some job. I helped take two boys out from under the machine lifeless and two crippled. The biggest thing was keeping the thing packed, and of course, all the other wear and tear constantly with the machine, gave no end of trouble. That is why I realize that dreams come true. I dreamed then of some sort of a manipulator above ground.

At present we do not have a blooming miill. We have a manipulator under 500-ton press that manipulates blooms, heavy forgings; Kennedy construction, and of course, hydraulic. Prior to that I helped install the equipment that went into the Wickwire plant in Buffalo, similar to the one at Grand Crossing, to be electric driven side guard and electric driven fingers. Was there for some time after it started operation and it worked very satisfactorily and was a decided advantage over the old hydraulic; but still I can see in looking over some of these slides, that the present day installation is much superior to that one.

P. H. Douglas*: This is an interesting subject, but covers a line of endeavor with which our company has been out of contact for so long that we would not attempt to suggest or dictate on the design of such apparatus. Tribute was paid here this afternoon to Mr. Wellman and his inventive genius, by one of the speakers, for which I wish to express my appreciation. In days gone by, the Wellmans fathered many such improvements. We hope to get back in that line ultimately and when we do, may have more to say.

R. S. Shoemaker†: One thought occurs to me while I have been listening to these three very able papers this afternoon.

That is the question of comparative operating costs.

If you are going to install a new blooming mill, you, of course, would have it motor driven, including the manipulators.

I do not think anybody today, unless for a very unusual condition, would install an engine-driven mill.

When planning to replace an existing steam engine with electric drive, it is a comparatively simple matter, because operating costs have been made available to all, through their publication in our proceedings. The problem, however, of replacing existing hydraulic manipulators with electric driven machines is in about the same status as the main roll drives of a few years ago. We must be able to place before our managements at least the approximate improvements in operating costs and increased tonnage expected before they will be justified in authorizing such a large expenditure.

We all remember what impetus was given to the installation of electric drive for blooming mills immediately after authentic operating costs were published. I believe that if the manufacturers of manipulators will make the same effort to have comparative manipulator costs published that it will react to the mutual advantage of the manufacturers and the steel mills.

†Master Mechanic, Edgewater Steel Co., Oakmont, Pa.

*Mgr. General Equipment Division, Wellman-Seaver Morgan Co., Cleveland, Ohio.

†Supt. of Maintenance, American Rolling Mill Co., Middletown, Ohio.

*Features of the New Electrical Installations at the Cambria Plant of the Bethlehem Steel Co.**

By F. W. CRAMER†

THE larger steel mills face a problem in the generation and transmission of electric power that deals with heavy concentrated loads, short lines, and immense quantities of power to transmit at comparatively low voltages. We have the short lines because the power is used within our plants, and the area of a plant is very small when compared with the area a public service company would serve to supply a similar load. We have the low line voltages of 2300 or 6600 V not only because the routes for the lines are such that it is difficult to install hgher voltages safely, but also because the standard main drive units are built for these voltages, and economic laws prevail against transforming to a higher voltage and reducing back to a lower voltage for such short lengths of line. These conditions present a problem in the selection of line and switching equipment that will successfully handle immense short circuit currents. When the contemplated plans are completed, the magnitude of these short circuit currents on this system will be in the neighborhood of 60,000 amperes at 6000 volts.

*Presented at Johnstown in connection with Inspection Trip, Saturday, September 25, 1926.

†Asst. Elec. Supt., Cambria Works, Bethlehem Steel Co., Johnstown, Pa.

Our generating system, at present, consists of three power houses whose installed capacity totals 42,750 KW. They are tied together by two 6600 volt circuits each consisting of 3—1,000,000 CM cables. At Power House No. 1, the three turbines generate at 2300 volts, and are tied in to the 6600 volt bus lines through 2—4000 KVA banks of transformers. About 2440 ft. from this power house, the bus lines are tapped, with FK-130-20-B oil switches on either side of the taps, to feed the 10,000 KW Gautier Mills load. Eight thousand, four hundred and fifty-seven feet (8,457') further, the lines are tapped in a similar manner for the No. 2 Power House tie lines. In this house, the two (2) 2300 V turbines are tied in through 2-3 phase—4000 KVA transformers. From this point, the bus lines extend 1680 feet further to No. 3 Power House. Although we have reactor choke coils at each end and in each tap on the line, the generating capacity, and the large synchronous load are capable of building up short circuit currents whose maximum instantaneous value may be 66,000 amperes at 6000 volts.

We are bringing this point to your attention to emphasize that large steel mills must install high grade switching equipment, so that in case a short circuit occurs, the oil switches will function, their rupturing capacity being in excess of the value of the short circuit amperes.

From this 6600 volt bus ring, and the 2300 volt buses in the power houses, are fed some 4200 motors, totalling 169,000 horse power. The feeder lines extend radially from the 2200 volt distribution points serving not only the plant, but also the underlying and surrounding mines of our Bethlehem Mines Corporation.

At the present time, No. 3 Power House contains a 15000 KW, at 80% P.F., 6600 volt turbine. As this is by far the most economic unit on the system, the load is kept between 15,000 and 18,000 KW at unity power factor about 20 hours per day. In addition to the other protective devices, overload relays are used on the turbine leads, so that the generator will be disconnected from the bus, in case a line switch fails, or when a short occurs on the loop system that is fed over both 6600 volt buses, and throws a double load on the turbine switch.

This power house is the first isolated phase installation in a steel plant, and is also a reverse of the usual design that places the oil switch mechanism and switchboard on the top floor. By having them on the generator floor, the station can be safely operated by two men on a shift. The 6600 volt bus construction is in duplicate, and switching is done by the remotely controlled FK-130-20-B oil switches, all of 2000 ampere rating, and having a guaranteed rupturing capacity of 60,000 amperes at 6000 volts. The safety devices prevent the disconnecting switches from being opened while the oil switch is closed, or the doors from being removed until the disconnecting switches are opened. In this station, the first place the 3 phases get together is at the outgoing line switch. There are two locks on each line switch, each having a different key. The keys are kept in the switch cells, so that the oil switches on both the east and west buses of any outgoing feeder must be opened, and the doors removed before the keys to open the line switch can be secured.

All equipment in the station is insulated for 15,000 volts, and built to withstand the mechanical and electrical stresses that would be caused by a short circuit of 80,000 amperes. The 6600 volt system is ungrounded with the exception of the bus potential transformers in this power house, which feed the voltmeters installed to indicate grounds on the system. All conduits have been run for the completed station of 3—15,000 turbines, and provisions made for 12 outgoing feeder lines all of 2000 ampere capacity. We might add that 2000 amperes can be carried on the bare 1,000,000 CM cables on this line without undue heating. This is due to the fact that there is always a moving current of air in the valley, and the temperature rise of the copper for a given load is far less than the calculations indicate, if based on indoor laboratory tests.

The 6600 volt bus lines are supported by insulators and hardware that has a guarantee of 22,000 pounds breaking strength. With this type of equipment, we were able to make spans of 300 ft. with the 1,000,000 CM hard drawn copper cable.

At the Gautier tower, where the 6600 volt lines are tapped, twelve (12) 1,000,000 CM—15,000 V cables are brought into the sub-station through 3" aluminum conduits. This station has both a main bus and an auxiliary 6600 volt bus, and is so designed that the bus tie switch will replace any 6600 volt switch that becomes disabled or needs inspection. It is possible to do this without opening the circuit.

For starting the five (5) motor generator sets, there is a common compensator breaker with control so interlocked that only one machine can be started at a time, and so wired that when the starting switch for any generator is operated, this compensator breaker closes with that starting breaker, and puts a reduced voltage on the synchronous motor. When the machine is up to speed, the starting control switch opens both the compensator and starting breakers before the running breaker can be thrown in. We might also add that there is overload protection on the compensator breaker that will function if trouble occurs when starting up. There are two duplicate compensators, each having a five minute rating, wired in parallel, so that if trouble occurs on one, the spare can be put in service by closing six disconnecting switches and opening six. Hence there is a duplicate set of 6600 volt equipment up to the synchronous motors.

These five (5)—2880 HP synchronous motors drive 10 D.C. generators, each rated at 1000 KW at 250 volts. Two of these can be used as starting generators for the Ward-Leonard system of starting the main drive motors. These ten generators can also be paralleled on the main positive and negative buses, which, in the sub-station, consist of 18—6x¼" copper bars.

The DC load of this station is a peculiar proposition, as we may have 30,000 amperes on the bus one minute, and only 1000 the next, which condition requires almost perfect brush setting and com-

pounding of the machines, so that in suddenly losing the load, the machine will divide the drop. The DC breakers and field rheostats for these machines are controlled from the benchboard. Another feature of the sub-station is the reinforced concrete design. The theory that the large mass of concrete would absorb the vibrations from the five sets has been used to a good advantage. The station has natural ventilation with grating so designed that the path of the air is sharply changed to cause the solid matter mixed with the air to drop in the basement. The enclosed synchronous motors act as fans to pull this air through the machines, and force it upwards toward the ventilators in the roof. During the cold weather, sections of grating are closed to retain the heat from the machines in the building.

Another feature of interest is the main DC bus tunnels that extends from the sub-station, 570 feet through the 48" concrete ppe tunnel across the mills. In the desingn of the tunnel, and in the bus construction, most of the plans had to be developed to suit our conditions. The principle of the bus construction, and type of expansion joints is similar to steam line construction. The bus is so installed that the sections can slide if expansion or contraction occurs. It is laid on insulated slippers, and has large rectangular offsets supported at the middle of the top members where the taps are made. The tunnel has a stack at the far end which induces a draft of cool air at all times. This circulation, together with the fact that the tunnel is under the surface, makes the air temperature resemble that of a coal mine. The temperature changes very little, and the small heat losses in the bus are carried away by the currents of air, so that the actual expansion and contraction of the long bus is exceedingly small. Man holes are provided wherever the bus is tapped; the tunnel is lighted throughout; and the design is such that a man can walk through its entire length.

In order to make inspections of this tunnel possible, an auxiliary DC bus was installed in the substation that can be fed either from No. 5 machine or from the main bus. A feeder line extends overhead across the buildings from this auxiliary bus that can supply power to all cranes in the new mills. By having a double throw switch on each crane runway feeder, it is possible, on Sundays, to operate all new mill cranes from the auxiliary bus, and have the main one shut down.

A brief description of the starting of a mill motor, and of the various interlocking schemes that had to be worked out to make it fool-proof, and fully protective of the equipment might be of interest.

You may have noticed, in addition to the large positive and negative buses, a small bus running through the tunnel, which we call the starting bus. The two generators that can be used for starting the main drive DC motors have a double throw switch on the equalizer pedestals, which is thrown up to connect with the equalizing bus when paralleling with the other machines, and down when in use as a starting generator. In the down position it eliminates the series field of the generator and connects the negative side of the machine to the starting bus. With the generator up to speed, the series field eliminated, and the shunt field separately excited, we have a shunt generator ready for starting the motors. The double throw switch connects this generator to the starting bus. The positive circuit breaker is open, and the rheostat of the machine has all resistance in series with the field, which gives a low potential across the machine terminals.

Out in the mill, you may have noticed the various starting pedestals. If a white light shows, it means that the starting generator is ready for service as described above, and if the green light is on, the motor rheostat is in the "full field" position. If a red light is burning, it means the starting bus is being used by another main drive unit, and this motor cannot be started until the bus is clear. The red light will continue to burn until the rheostat on the starting generator has returned to the "no field" position. If the starting button is pressed, when a red light shows, nothing will happen, as the control system to the motor breakers is locked out both electrically and mechanically.

If the operator makes his set up on the pedestal for forward or reverse, and if the motor shunt field and the overspeed trip are closed, the rheostats in the off position, the motor negative breaker open, and the safety switch on the pedestal closed, then he can press the master start button, and the motor will be automatically brought up to speed. This master start button will close the motor positive breaker and the negative start breaker, which in turn closes an auxiliary contact that closes the positive circuit breaker on the starting generator. We now have a circuit of low potential from the starting generator to the mill motor. An auxiliary contact on the positive generator circuit breaker closes the circuit to the motor drive on the starting generator field rheostat, which starts to function and builds up voltage, and this voltage soon reaches a value where the mill motor starts to revolve. This voltage continues to build up until it equals the main bus voltage, at which time the balancing relay operates, which closes the main motor negative circuit breaker, and this in turn opens the negative starting breaker. This closes an auxiliary contact that energizes the trip coil of the positive circuit breaker on the starting generator. When this breaker opens, it closes a circuit that energizes the field rheostat motor in the opposite direction, and the starting voltage is again reduced to almost zero. This cycle takes about forty (40) seconds.

The mill motor is now running at the bottom speed, and the operator raises it to his rolling speed by pressing the button that controls the motor driven field rheostat.

In stopping a motor, the master stop button is pressed which trips both motor circuit breakers. The positive breaker closes an auxiliary contact which completes the circuit of a contactor across the motor terminals, which opens the starting breaker control, and prevents the motor breakers from closing until the armature has stopped revolving. The field rheostat motor circuit is energized when the main negative running circuit breaker opens, which returns the arm to the full field position.

The interlocking wires between motors are all carried back to the substation where a series of switches enable us to eliminate any of the four mills in case control trouble develops.

This scheme gives the easiest starting characteristics that could be desired, and very little maintenance trouble. It might interest you to know that with four mills in operation, the starting generator averages over 125 cycles per day, and since May 1st., by actual count, we have had about 10,000 motor starts. This is an indication of the ease with which the mills can be started and stopped, and shows up to an advantage in the mill power costs, as the periods of running the mills on the friction load are kept to a minimum.

The main drive motors on these new mills are all variable speed of a 2/1 or better ratio. They are of Allis-Chalmers make with a two-circuit frog leg winding. On the twin 3000 HP motors in the 14" and 13" Mills, special series fields have been added that cross connect with the armatures, and the original compounding effect eliminated, which assures an evenly divided load between the motors at all speeds with very close regulation. By adjusting the brush position, and the series shunts, it is possible, with this design, to get most any speed regulation from falling to rising with full load on the motors.

The 3000 HP twin motors on the 14" Mill are now adjusted to give a drop of 18 RPM at the top speed with 150% load on the motors. Closer regulation seems to remove the electric cushion that exists when the billet enters the rolls, and causes the shafting and gears to transmit the "bump" throughout the drive.

The 10" Mill, which is driven by three separate motors, is of a design that makes it possible for a portion of the finished product to be on the hot bed before the end of the billet leaves the furnace. With this layout, a close regulation of the motor speeds was required. In order to be assured of this close regulation, a special oil regulating set was installed that would function in case the motor speed changed. Up to the present time, this special equipment has not been used as the inherent regulation of the motors has been sufficient to meet the rolling requirements.

The hot bed run out rollers, on the 9", 10" and 13" Mills, are of the cone type, each driven by a fractional horse power AC motor. In each of these mills is installed a motor generator set remotely controlled from the pulpit that furnishes power for the cone roller motors. The generators are driven by variable speed DC motors, and by changing the motor speed, the frequency of the generator can be set at a value that will give the required speed on the cone roller motors. In addition to the three sets, there is a spare set installed, that can be used on any of the three mills by throwing the double throw switches in the down position. The individual motors on each run are wired in five circuits, every fifth motor being on the same circuit with both individual fuses on the motors, and a circuit breaker on the switchboard. This design allows the mill to operate in case of individual motor trouble, or line trouble on any of the five circuits.

The four new mills, together with the warehouses, are served by 23 cranes of either 10 or 20 ton capacity. The billet yard cranes are of a design that has two overhung drums at right angles to the bridge, driven by one hoist motor. The centers of the hoisting cables are such that 30 ft. billets can be handled without using a spreader beam. These cranes are equipped with 95 motors having a total horse power on the crane rating of 4,675.

The auxiliary motors on these mills are all controlled by magnetic panels, master controllers, and limit switches. So far as it was possible, the various cycles of operation were made automatic, the operator starting the equipment, and the limit switches completing the operation.

Throughout these installations, in addition to ease of operation and durable construction, the problem of safety was given deep consideration. The crane stairways, repair platforms, runway circuit breakers, location of panels, and accessibility for repairs are a result of this study, and we believe that the repairmen as well as the other employees have been protected against operating hazards in keeping with the safety standards of the present time.

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*New Rolling Mills—Gautier Plant, Cambria Works, Bethlehem Steel Co., Johnstown, Pa.**

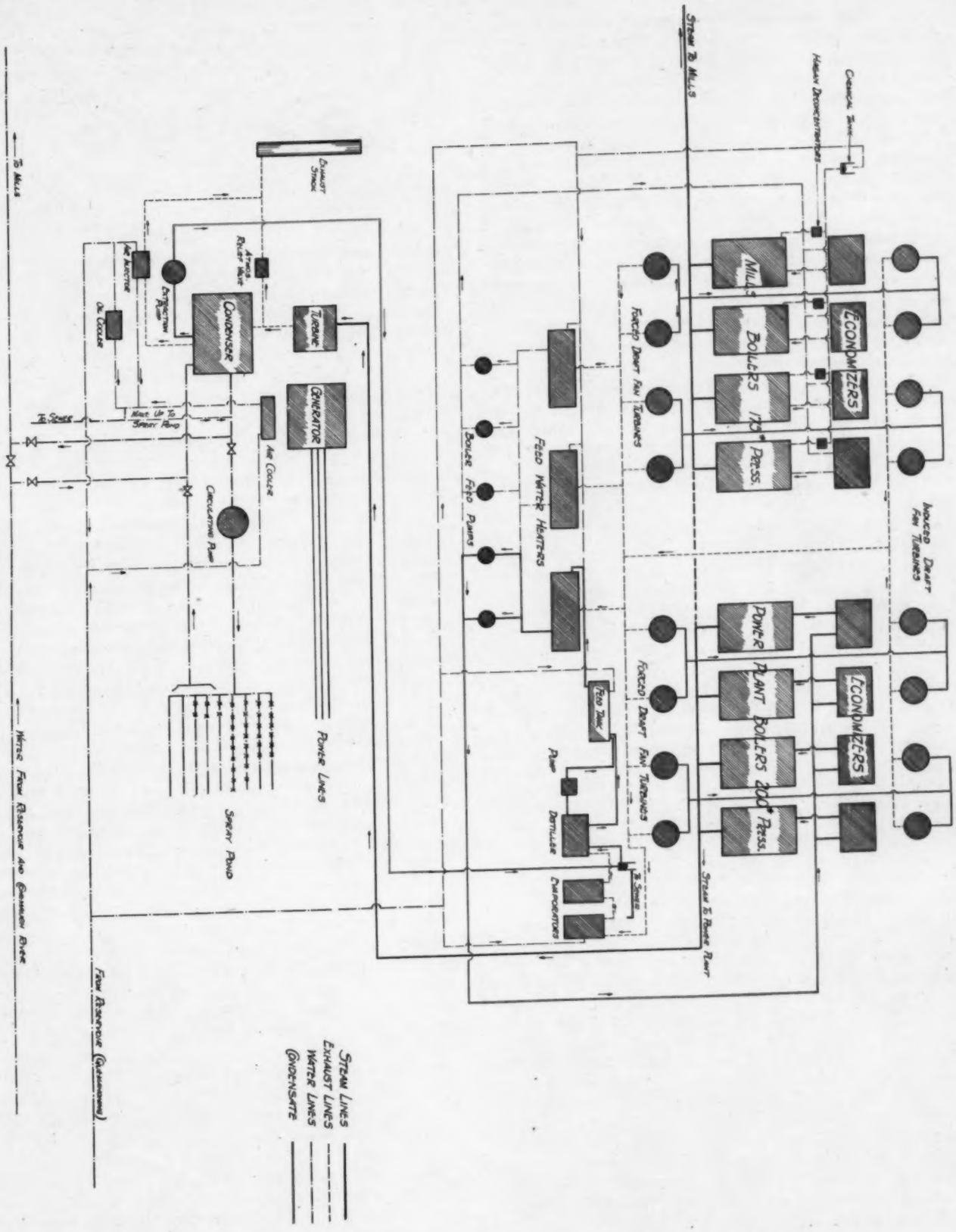
By R. H. STEVENS†

IN connection with the Cambria Plant of the Bethlehem Steel Company here at Johnstown, you gentlemen no doubt have asked yourselves a question that occurred to me when I first came to this plant, and that is, "why was a plant of this size squeezed into a gap in the mountains?" The reason for this is not apparent, unless you know a little of the early history of the old Cambria Iron Company, which I think would be interesting to repeat at this time.

This is the oldest plant in the United States which has mined and worked its own fuel and ore from the beginning of its operations. The ore was located in these hills and timber was plentiful. The

*Paper presented in connection with Inspection Trip to Cambria Works, Johnstown, Saturday, September 25, 1926.

†Chief Engineer, Cambria Works; Bethlehem Steel Co., Johnstown, Pa.



Steam Flow Chart

first blast furnaces were erected adjacent to the ore mines, which is approximately the present location of our 1 to 4 blast furnaces.

The local manufacture dates back more than a century to a charcoal blast furnace built in 1808 on Shade Creek, and a forge below the mouth of Shade Creek, built in 1811. A forge at Johnstown in 1809 was operated to 1822. Cambria Furnace, on the Laurel Run, was built in 1841, and with other local blast furnaces, all charcoal, became part of the Cambria Works, built in 1853, at which date the Rolling Mill and four Coke Blast Furnaces were started. These furnaces all used the local ore, a carbonate of iron with lime sufficient to make it self-fluxing. This made a hard white phosphoric pig, and when put into rails, gave the Cambria Iron Company rails a high repute. This ore was brought out to a shelf on the hillside, about level with the top of the furnaces and was spread out in alternate layers of charcoal and ore and was roasted in this way to eliminate sulphur.

The completion of the Pennsylvania State Canal through Johnstown in 1834 furnished the transportation, and the occurrence of this iron carbonate ore and coking coal at Johnstown gave birth to the Cambria Works The Pennsylvania Railroad, built in 1854, gave additional outlet and market for the rail product.

In 1858, John Fritz, who was Chief Engineer at the Cambria Plant at that time, invented and built the first three-high rolling mill in the country, and it was here, too, at about the same time, that William Kelly made experiments with a converter antedating the work of Sir Henry Bessemer, thus preventing the latter from obtaining American patents on this process, which would have thrown the full control of this branch of the steel industry of the United States into English hands. While experiments on the Bessemer process were made by Kelly in 1857, it was not until 1869 that a regular Bessemer Plant was started here.

The Cambria Iron Company was also one of the pioneers in the installation of by-product coke ovens in the United States, having put in operation two thirty-oven batteries of Otto Hoffman ovens, with the necessary by-product equipment for the production of tar and sulphate in 1895. These were followed by the addition of two fifty-oven batteries of Otto Hoffman ovens in 1898, additional ovens being built from time to time, until, prior to the large Clairton installation of the United States Steel Corporation, we were the largest operators of by-product ovens in the United States, having a total of 700 ovens, 286 of these ovens being of Cambria design, the balance were made up of Otto Hoffman, Gas Machinery Company, Koppers and Semet-Solvay. Of these 700 ovens, five batteries, or 214 ovens, have been abandoned and we are now building a new battery of 77 Koppers Becker Type Ovens in their place. After the completion of these new batteries, we will have 563 ovens in operation, giving us a total production of over 5,000 gross tons of furnace coke per day.

We have in this plant at present ten blast furnaces rated at approximately 145,000 tons of pig iron per month, one of which has recently been entirely rebuilt to a 20'6" hearth diameter, 24'-0" bosh, 17'-0" diameter stock line, 94'-0" high, with provision made so that this furnace can be enlarged to 22'-0" hearth, if, in the future, it is found advisable. This furnace has all modern improvements, including an elevator to the charging platform, Berg Mud Gun, Baer explosion valves on the bleeders, electric hoist and bell operating rigs, crane in cast house and McKee distributor.

The Bessemer Plant has a capacity of 55,000 tons per month, but, due to the falling off of the requirements for Bessemer steel, the output has reduced to approximately 25,000 tons per month.

We have twenty-nine open hearth furnaces with a rated capacity of about 127,000 tons per month; three blooming mills, one slabbing mill, two billet mills, two structural mills, one rail mill, one sheared plate mill, one Universal plate mill, twelve bar mills, one rod and wire plant, one axle plant, one rolled steel wheel plant and one plant for the manufacture of steel railroad cars, either gondolas, hoppers, box or tank cars.

Of the recent improvements in the plant, the most outstanding features are the four new Gautier Bar Mills and a Power House for furnishing additional electric current for same.

The Gautier Plant has always been noted for its production of high quality material. This preeminence was so marked that the term "Gautier Finish" became a trade synonym for highest quality. This high quality finish in the old days brought an additional price which offset the increased cost of manufacture. Due to competition, however, and the installation of large tonnage mills throughout the country, it became more difficult to maintain the necessary differential to warrant the continuation of the old type mills, even with their high quality finish. Consequently, in the latter part of 1924 it was decided to build four modern mills capable of producing large tonnages, and of maintaining the high grade finish for which Gautier was noted. With the installation of these four new mills, it was proposed to abandon six of the thirteen old mills. Some of the units at this plant were already modern and efficient The mills proposed were as follows: A 14" mill for rolling structural shapes and small rails, a 13" mill for rolling rounds, squares and flats in the following sizes: rounds 1" diameter to 3" diameter; squares 1" to 2½"; flats up to 4½" wide. A 10" mill for rolling the smaller rounds, flats and squares. Lastly, a 9" mill for the purpose of rolling small, special shapes, such as window sash sections, etc.

These four mills were intended to replace the 8" No. 1, 8" No. 2, 10", 12" No. 2, 13" and 14" Mills.

The buildings were designed with special reference to minimum amount of steel, good light and ventilation. A special feature of construction is the use of wide monitors. The fixed sash on the sides of the monitor slopes from top to bottom, so that the panes of glass are practically self-cleaning on the outside. Wherever possible, fixed sash has been provided in the side and end walls of the buildings. Buildings are steel framework enclosed with 4½" of

brick which is supported by and held in place laterally with steel girts supporting the windows. At the apex of the monitor, standard ventilators are installed for inducing ventilation, the air entering the buildings near the floor level through doorways which take up half the width of each bay.

It was the desire to make a finished job, particularly in reference to safe access to the mills. An underground manway tunnel extends from the entrance across all mills with separate entrances to each mill. Wherever possible, the tables are floored with cast iron plates for safe operation. Ample room is provided underneath the tables, hot beds, etc., for safe and easy access for cleaning. Stairways are provided in place of ladders wherever possible. Platforms are provided for access to cranes and provision made at places for repairs to the cranes. Monorails are carried above the monitor windows on the inside, on which will operate movable platforms, from which the windows can be cleaned.

Provision is made for access by truck to each of the mill buildings, billet yards and shear building for the handling of spares or the shipment of small local orders. The mill buildings and billet yards are at right angles to the shear building and warehouses, and with the exception of the 14" Mill, each mill delivers into a common shear building which has a span of 110 feet.

The 14" Mill delivers into No. 2 and No. 3 warehouses, which with No. 1 warehouse, are parallel to the shear building. Each of these warehouses is 101 ft. span, and approximately 540 ft. in length. The warehouses are located on the site of the old mills.

Four cranes take care of the requirements of the shear building, and two cranes are provided in each warehouse for handling materials to stock or for shipment. Thirteen cranes take care of the needs of the mills and billet yards. Our layout differs somewhat from the usual arrangement of bar mills, in that our billet yards are parallel with and located between the mill buildings, and the track arrangement is such that from four to ten cars of billets can be delivered to each of the billet yards and located under the crane, so that material from any car can be delivered direct to the furnace or to the billet yard. This arrangement has worked out very satisfactorily, and has cut out transportation costs very materially. All of the billet yards are covered.

The new mills were designed for the use of approximately 30 ft. billets and the billets are handled from the car to the yard or from the car to the furnace without turning. The ends of two of the tracks from the billet yards are extended into the shear building for receiving scrap from the shears.

The new mills were laid out on a triangular piece of ground, located northwest of the old Gautier Mill Buildings, and it was proposed to put these mills in and have them running before any of the old mills were abandoned. At first, this piece of ground did not seem adaptable for a modern installation, but by placing the mills requiring the greatest length on the long leg of the triangle, and the shorter mills near the apex, we were able to make a very satisfactory layout and install the four mills, together with the shear building, into which three of these mills deliver their product, and have all four mills operating before any of the old mills were eliminated.

The 14" Mill is designed to roll channels, beams, angles, automobile rim sections, light rails and flats. This unit is housed in a building 600 ft. long and is served by two heating furnaces, the first having a hearth 32' x 56' and the other 17' x 42'. The first furnace is used for the general run of the mill. The second and smaller furnace is used for handling special materials. For instance, blooms which do not meet the specifications for axle requirements will furnish very satisfactory material for the rolling of light rails, and these blooms would be heated up in the smaller furnace. This mill is provided with ten stands of rolls, five 18" roughing stands and five 14" finishing stands. The stands are all open so that the piece never is in two stands at the same time. Stands No. 1 to No. 5, inclusive, are arranged in tandem, while the remaining five stands are staggered. On leaving the furnace, the heated billets pass through the first five stands, traveling from the front to the rear of the mill. After leaving the fifth stand, the piece is transferred, by a side transfer, to No. 6 stand, through which the piece passes towards the front of the mill. Similarly, there is a side transfer from stand No. 9 to stand No. 10. When it can be done advantageously, it is possible to omit stands No. 7 and No. 8, delivering the material direct from No. 6 stand to No. 9 stand. The five roughing stands and No. 6, No. 9 and No. 10 finishing stands are operated by a 3000 H.P., D.C. 150/300 R.P.M. motor through line shaft and bevel gears, while No. 7 and No. 8 stands are driven separately by a 1500 H.P., D.C. 150/300 R.P.M. motor through spur gearing. On the way to the hot beds, the rolled pieces or sections pass under two motor-driven hot saws, with gauge, which are installed for the purpose of cutting the pieces into lengths specified. The material then continues on over the roller tables to a hot bed 180' long, which is of the standard sweep type, equipped with individual drag-offs. Thence, it goes through straightening rolls to a cross transfer bed serving two shears which deliver in turn to (a) No. 3 warehouse, (b) No. 2 warehouse.

The 13" Mill is used for rolling rounds, squares, flats and concrete bars in the larger sizes, and is housed in a building 500 ft. long. It is served by one 32' x 60' hearth heating furnace, and has five 18" roughing stands and five 13" finishing stands. This mill is also of the open type, so that at no time is a piece being rolled in more than one stand. As the stock leaves the heating furnaces, it passes through the first five stands, which are arranged in tandem. The general arrangement is such that No. 5 and No. 6 stands can be omitted in rolling, as a side transfer is provided from No. 4 to No. 7 stand as well as from No. 5 to No. 6 stand. The five roughing stands and No. 6, No. 7 and No. 8 finishing stands are operated by a split 3000 H.P., D.C. 150/300 R.P.M. motor through line shaft and bevel gears, while No. 9 and No. 10 stands are driven separately by a 1500 H.P., D.C. 150/300 R.P.M. motor through spur gearing.

In front of No. 2 stand we have provided an air operated edging device, which is out of the line of the piece being delivered from No. 1 stand until it is desired to turn the piece, when the turning motion advances the turning rig to connect with the piece and turns it on its own center, leaving the jaws open on top for easy removal of the piece in case of a cobble. In front of No. 4 stand, as well as in front of No. 6 stand, there is provided a roller edging device which edges rectangles, heavy flats or ovals for entering these stands. When rolling the light weight sections and using the ten passes, there are as many as eight bars in the mill at one time. On leaving the finishing pass, the material is delivered to a 180 ft. hot bed, which is of the notch, carry-over type.

This hot bed is one of the features of the 13" Mill and was designed by the Company's own Engineering Department, and built in the Company's shops. The finished bars coming from the last stand are received by a run-out table, equipped with cone type rollers. When the bar is free of the rolls, the axes of the cone type rollers are shifted askew, which transfers the bar onto the cooling bed. Cone rollers are driven by small, individual A.C. motors which are operated from a motor generator set having a variable speed motor, and the speed of the cone rollers is set to suit the delivery speed of the material. The hot bed, 24' x 180' in size, is divided cross-wise into thirty notches. The dead load is balanced, and when material is in transit over these beds, at no time is more than one-half of the weight lifted. Shuffle bars are provided at the discharge end of the notches and are driven by eccentrics 180 degrees apart. These deliver the stock onto a roller table which conveys it towards the rear of the mill to a shear, where it is cut into commercial lengths, as in standard bar mills.

The 10" Mill, which is more of a tonnage unit and designed to produce rounds, squares, flats and concrete bars, etc, is a ten-stand mill and served by a 32' x 30' heating furnace. Delivery is made directly into four 12" roughing stands of the continuous type. This roughing train is driven by a 2000 H.P., D.C. 200/600 R.P.M. motor. Then delivery is made into four 10" finishing stands arranged for looping and from these into two 8" stands which are provided for finishing small sizes. The 10" train of finishing stands, which are staggered over the floor, is driven by a 1700 H.P., D.C. 250/500 R.P.M. motor, and the two 8" stands by one 900 H.P., D.C. 425/640 R.P.M. motor. From the finishing stands delivery is made through a flying shear which cuts the sections into convenient hot bed lengths, after which they pass onto a notch-type carry-over hot bed 330 ft. long, and thence to one shear and gauge as in the 13" Mill. This mill is also provided with reels for reeling and a coil conveyor for cooling coiled materials.

The flying shear is of the rotary type, with discs set at an angle of 45° to the path of the bar and operated at a speed that will not retard the section. A pivoted guide throws the stock across the knives and then back again into the regular path of travel. The knives separate on the reversal of the pivoted guide.

The 9" Mill is, primarily, a jobbing unit, and is designed to roll miscellaneous shapes. 30 ft. billets are delivered to this mill and sheared to proper length before being charged into the furnace. The mill is served by a 17' x 25' heating furnace, delivery being made to four 12" roughing stands arranged in pairs and in tandem, with a full, open space between the first and second pairs. These rolls are driven by a 1000 H.P., D.C. 200/480 R.P.M. motor. From the roughing stands, stock passes to a five stand train made up of two three-high stands and three two-high stands with 9" rolls. The first four stands are driven by a 1000 H.P., D.C. 200/480 R.P.M. motor, while the fifth or finishing stand is driven by a 500 H.P., D.C. 250/600 R.P.M. motor. Stock is either looped from one stand to another or is run out on chutes, when it is to be fed into an adjacent stand of rolls. The steel, leaving the last pass, is taken away from the mill on a cone roller run-out table, dropped into a "V" notch, from which it is lifted by a carry-over bar and transferred across a flat hot bed 220 ft. long to another roller table which leads to a shear and gauge at the end of the mill, as in the case of other mills. This hot bed was also designed in our Engineering Department and built in our local shop.

The heating furnaces on all mills are provided with a carry-over bed on the charging end to advance the stock to the charging table without the necessity of the men dragging it. On the 14"-13" and 10" Mill 30 ft. furnaces, the billets are charged in the side of the furnace through a door and are advanced through the furnace by means of electric pushers. On the 17-ft. furnace in the 14" Mill, and in the 9" Mill, the stock is end charged and pushed through the furnace with electric pushers. On the 13" and 14" Mill 30 ft. furnaces, a special type of water-cooled roller is provided in the furnace which, by means of a specially designed outlet, keeps the roller always full of water and allows any accumulated air or steam to escape. These furnaces are equipped with a pinch roll and bar for side discharge, the pinch rolls and tail block being carried on slides which allows the bar to be moved over the full width of the hearth for pushing out the stock. These slides are extended so that the entire pinch roll can be transferred to one side and give very good access to the furnace door and hearth. These furnaces are both flat bottom and handle stock from 3" x 3" to 6" x 6" billets on a dry hearth being arranged with several rows of magnesite brick in place of skid pipes. All of the furnaces are equipped for coke oven gas, with either tar or oil as an auxiliary fuel. They are equipped with automatic control for the air when using coke gas, so that the volume delivered will suit for the proper combustion of the gas required There is also a balanced draft control on the stack. The air for combustion is passed over the roof of the furnace to a fan, thence through metal recuperators on its way to the burners. With this arrangement, these furnaces have shown unusually good fuel practice.

Each of the mills is equipped with circulating oil system for bearings and gears, with provision made so that the entire oil in any system can be delivered to a central oil house, equipped with cir-

culating pumps, centrifuges and storage tanks, where the oil can be cleaned and rested at frequent intervals. The circulating system for the tar is also located in the central oil house.

Five tracks have been extended at right angles through the shear building and warehouses for shipping material. The entrance to these tracks is through courts between the buildings. These courts also serve as means for getting fresh air into the mill buildings.

These mills are operated from our No. 3 Power House through a sub-station, which will be treated upon in detail in a special paper by Mr. Frank Cramer, Assistant Superintendent of our Electrical Department.

As you gentlemen are more interested in the electrical generation than the mills proper, I will go a little more into the mechanical detail in reference to our boiler house and power house.

The No. 3 power house and the Franklin Mills boiler house, located at the extreme eastern end of the Franklin Plant, are approximately two miles from the new Gautier Mills. The buildings are separated by a network of tracks, which necessitated the erection of a steel viaduct to support the steam lines connecting the boiler house with the power house.

The Franklin Mills boiler house replaces an obsolete boiler house, and in addition, provides the steam for the 15,000 K.W. turbo-generator installed in No. 3 power house. Extensions may be made to either end to take care of any additional turbo-generators required. It is located close to the major steam units at the Franklin Mills and between the main line tracks of the Conemaugh & Black Lick Railroad and yard service tracks.

Many of the features incorporated in the design and equipment of these units present novel departures from the conventional power plant practice, the most interesting of which are:

(1) The boiler house operates as two distinct units. One unit with a steam pressure of 175 pounds and 125° superheat, delivers steam to the Franklin Mills; the other with a steam pressure of 200 pounds and 125° superheat, delivers steam to No. 3 power house. One boiler in the house can be used for either unit.

(2) A divided fuel bin, extending the entire length of the boiler plant, with separate chutes to the double compartment stoker hoppers, is installed to permit burning a mixture of local coal and large size screenings from the blast furnaces and coke plants. This construction allows for the burning of all coal or a mixture of coal and coks, depending upon the supply of coke screenings available.

(3) The boilers connected to the turbine are supplied with feed-water, composed of condensate from the turbine and distilled water from evaporators. and the boilers connected to the mill's steam line are supplied with raw Quemahoning water, treated in the boiler to prevent scale formation.

(4) The surface condenser on the turbine is so arranged that the mill service water from the South Fork intake on the Conemaugh River and the Quemahoning Reservoir can be passed through it on the way to mills, when there is an abundance of water available at these sources. When it is necessary to conserve water, the condenser operates on a cooling pond.

The boiler installation consists of (8) 977 H.P. boilers. They are composed of (4) 42" drums and 504 tubes (36 tubes wide and 14 tubes high) 20 ft. long and having approximately 9768 sq. ft. of heating surface. Each boiler is equipped with steam purifiers and is served by an economizer having a total net heating surface of 6290 sq. ft. Each boiler is also equipped with a superheater which raises the steam about 125°.

Coal or coke is delivered to the track hopper at the boiler house in railroad cars. Two semi-automatic skip hoists elevate the fuel from the track hopper and dump it into a hopper located in the dust-proof conveyor gallery over the fuel bins. From this hopper the fuel passes onto a shuttle conveyor in the conveyor gallery, which transports and distributes the coal or coke to its respective compartments in the fuel bin.

The stokers are of the "Underfeed" type and consist of (12) retorts per boiler. The hoppers are arranged to receive coal and coke in separate compartments, formed by a movable partition which can be adjusted to any desired mixture. The coke rides the coal to the retort.

The bottom of each boiler ash hopper is fitted with gates which are opened and closed by means of steam cylinders. Standard hopper cars are used for ash disposal. A car haul with endless rope is used for handling both the ash cars inside of the building and the coal cars on the track outside of building. Soot from the hoppers under each of the economizers is conveyed by inclined pipes to the standard hopper cars receiving ashes.

The forced draft for the stokers is supplied by fans located in the basement floor. These fans, at 250% boiler rating, each have a capacity of 33,000 cubic feet per minute at 4.2" static discharge pressure and are driven by turbines through reduction gears. Each fan discharges into a concrete duct which delivers the air to one boiler stoker.

The induced draft for the economizers is supplied by fans located on the economizer floor immediately over the boiler settings. These fans, at 250% boiler rating, each have a capacity of 63,000 cubic feet per minute at 3.5" static discharge pressure and are driven by turbines through reduction gears. They discharge through individual stacks to the atmosphere.

The condensate from the steam turbine in No. 3 power house is piped so that it passes through the "Distiller Condenser" for the "two vertical type low pressure evaporators" (containing 500 sq. ft. surface) before being delivered to the feed tank supplying the boilers on the turbine. The condensate line is broken just after entering the boiler house by the installation of a funnel. This is done to protect the turbine, should the condensate for any reason be backed up in the line; to assure a constant head on extraction pumps, and to allow the wasting of condensate to sewer should it become contaminated due

to leaky condenser tubes. The feed tank which receives the condensate from the turbine, and the distilled water from the evaporators, is equipped with a float valve which delivers pure water to same, in case the condensate and the distilled water do not meet the requirements. The boilers on the mill steam line are supplied with Quemahoning water, clean, but with a high acid content. An apparatus for treating this water within the boilers, to prevent scaling, is installed in each boiler. There are three "Hoppes" feed-water heaters (each with a capacity of 241,500 pounds of water per hour), arranged to deliver to any one of the four turbine driven boiler feed centrifugal pumping units. One feed-water heater is connected to the boilers serving the turbine; another to the boilers serving the mill units; and the third for either service. The exhaust steam from the turbines on the forced and induced draft is piped to the feed-water heaters. Each boiler is equipped with one feed-water regulator.

Each unit delivers steam through a 10″ non-return valve and 10″ long bend to a common header 20″ and 24″ diameter, running the full length of boiler house, and having a large expansion U-bend in the center. One end of this line is continued outside of house to serve the mills, while the other is continued to No. 3 power house. The mills section of header (175 pounds pressure) is connected to the power house section (200 pounds pressure) through a by-pass with pressure regulator, which will allow surplus steam from power house end to go to mills

The boiler house is of brick and steel, on a reinforced concrete matte foundation, approximately 48′-6″ wide and 303′-4″ long. All floors in the boiler house are of concrete with a smooth finish. The roof consists of a concrete slab on which is laid a built-up covering of felt and asphalt.

The No. 3 Power House contains a 15,000 K.W. 80% P. F. turbo-generator, house in a steel frame. brick-enclosed building 80′ x 100′ with switchboard section arranged for two additional units.

The turbo-generator is supported on a structural frame that is enclosed in concrete and erected on a heavy reinforced concrete matte, that is independent of all building footings. It is served by a 50-ton crane. The turbine is capable of delivering 18,750 K.W. with steam pressure at the throttle of 200 pounds and 185° superheat, and pressure at exhaust to be 1.75″ absolute.

The generator is ventilated by means of a U-Fin air cooler installed in an enclosed air system. This cooler is capable of handling 70,000 cu. ft. of air per minute at 104° F and 0 gauge. The water circulating through the air cooler is discharged into the outlet pipes on the condenser, where it forms part of the make-up to spray pond.

The turbine is equipped with regenerative condenser (two flow type), having a total cooling surface of 24,000 sq. ft. and capable of condensing 250,000 pounds of steam per hour, and of maintaining a vacuum of 29″ when supplied with 24,000 gallons of circulating water per minute, at an inlet temperature of 70° F.

The condenser is rigidly connected to the turbine and supported on calibrated springs arranged to meet all conditions of loading. It is equipped with two 3-stage air ejectors, each capable, with full load on turbine, of maintaining 28″ vacuum against an air leakage of 10 cu. ft. per minute at 80° F. and atmospheric pressure.

The exhaust vapors are piped into atmospheric exhaust stack leading from turbine. The cooling water is taken from Quemahoning lines and discharged into circulating pipe from condenser where it also forms part of the make-up to spray pond.

Rubber expansion joints are used between circulating water lines and condenser.

Two extraction pumps, each capable of handling the full load of 250,000 pounds per hour, deliver the condensate to boiler house against a head of 25 pounds per square inch. The atmospheric exhaust is equipped with an automatic relief valve, which opens when condenser pressure is greater than atmospheric pressure. The turbine is fitted with vacuum breaker which operates by hand, or is actuated by turbine governor when speed becomes excessive.

The water mains to Franklin Plant are by-passed through the condenser before reaching the mills, but when water is scarce, a closed system consisting of spray pond and circulating pumps may be used. A spray pond was chosen instead of cooling towers as we expect the pond to lie idle at least nine months each year.

Two of the three 20″ centrifugal pumps, each capable of circulating 12,000 gallons per minute against a head of 100 ft. are required with full load on the turbine to maintain the desire vacuum.

The cooling pond is a reinforced concrete basin, approximately 230 ft. wide and 250 ft. long. It has nine lines of pipes extending across the width of the pond, supplying 120 spray head with 600 center jet nozzle.

The regenerative condenser, vertical extraction pumps, air ejectors and cooling pond circulating pumps at the power house, also the evaporators and distiller-condenser at the boiler house, were manufactured by the Moore Plant of the Bethlehem Shipbuilding Corporation.

The intake to the South Fork pipe line, one of the mill supplies, is located on the Conemaugh River, seven miles from No. 3 power house, at which point we are installing two traveling screens and are replacing an inadequate lime treating plant, in order to put the river water in condition for condenser and mill purposes.

The treating plant consists of a jaw crusher, bucket elevator and circular bin for preparing and storing burnt lime a rotary mixing machine with screw feed and refuse discharge trough for mixing burnt lime and water; a trough with distributing board for discharging milk of lime uniformly to water in intake to pipe line. Two line mixing tanks are provided as spare equipment for preparing milk of lime with outlet pipe delivery to intake. The plant handles about two carloads of burnt lime per week.

Three Hundred and Seventy-Two Days

No Lost Time Accidents*

Coke Plant Passes Mark of a Perfect Year

Illinois Steel Co., Joliet, Ill.

EVEN greater than a lifetime spent in amassing a fortune is the humanitarian motive and work of these Safety Committeemen, a part of whom are pictured above, in removing a hazard unknown, which will prevent serious injury to some one of our fellow workmen and secure his happiness. It is a more enlightened work and it belongs to the time when our actions are dictated by our conscience and prompted by a desire to do a good and vital thing which may bring the greatest blessings and happiness to others as well as ourselves even to saving a life, the most precious of all human assets.

The results made in the Accident Prevention Campaign conducted under the guidance of these Safety Committeemen is another instance of what remakable results can be achieved when the entire organization is whole-heartedly fighting with the committeemen in removing hazards to prevent an accident.

Several distinctive records or exceptional long periods of days were recorded but real achievements in Accident Prevention started on January 20th, 1921, when the entire Coke Plant department successfully contined on for the next 172 consecutive days without a single lost time accident.

A Group of Coke Plant Safety Committeemen

This record was followed by many other notable achievements and during the year 1922 an accident record, without a single over seven day accident, with but three lost time accidents for the entire twelve months and with periods of 122 consecutive days, 159 consecutive days and 108 consecutive days were recorded.

During the years 1923, 1924 and 1925 but two over seven days time lost accidents were caused and recorded each year, with consecutive periods of 119 days, 304 days and 200 days without a single lost time accident.

The last accident for this department was caused on September 6th, 1925, and from this date to and including September 13th, 1926, as we go to press, a period of **372 consecutive days** have been recorded as their present and best "No Accident" record.

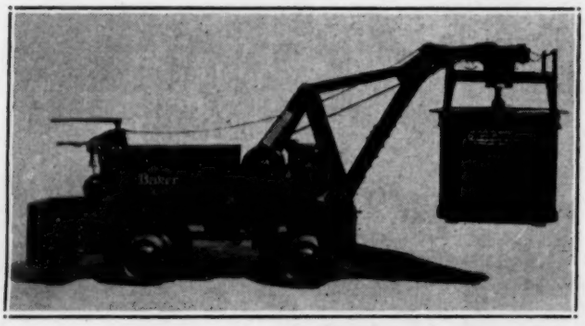
Mr. George P. Wardley, Superintendent, Mr. H. H. Jones, Assistant Superintendent, Mr. Frank Callahan, Assistant Superintendent, Mr. Leon Kelly, General Foreman and Chairman of the Coke Plant Safety Committeemen, all of the associate foremen, Safety Committeemen and individuals are to be highly praised for this successful co-operative Safety enthusiasm responsible for their present and best Accident Record, and congratulated for this distinctive accomplishment in Accident Prevention.

*The Mixer, Illinois Steel Co., Joliet, Ill.

Items of Interest

The accompanying photograph shows a crane type of electric truck designed by the Baker-Raulang Company, Cleveland, Ohio, for cupola charging. This machine operates in connection with Chisholm & Moore one ton charging buckets and makes use of the Morgan patented bucket yoke.

The truck itself is assembled principally of standard Baker parts; that is, the axles, controller, automatic switch, hoist, hoist controller, limit switch, etc, are all inter-standardized with all other models



of Baker trucks and tractors. The motors receive power from a 48-volt storage battery contained in the large steel box near the driver's end of the truck.

The Morgan charging bucket is circular in shape with a conical bottom. In operation the bucket is loaded and picked up by means of an eye fastened to the center of the bottom. When it is raised the four dogs on the yoke engage with the angle iron ring around the top of the bucket. To discharge the bucket it is only necessary to reverse the power on the hoist. This lowers the bottom while the shell is held up by the yoke. Because of the conical shape of the bottom the charge is spread evenly around the cupola. To place the bucket back on the floor the bottom is raised until it engages the shell and raises the ring clear of the dogs. The dogs are then held clear of the ring by means of the chain leading back to the operator's position while the bucket is being lowered. The upward travel of the hoist is protected with an automatic safety switch which cuts off the power when the bucket has been raised so that the ring is one inch above the dogs.

The boom is strengthened with a steel plate on the side toward the fire. This keeps the heat away from the cable and also away from the hoist and other truck operating parts. The cable is a special steel center rope well suited for this purpose.

A new metal melting pot, with a capacity of approximately 1,000 pounds, has been added to the General Electric line and is now on the market. This pot, utilizing the electric heating principle, is practically the same as other standard General Electric melting pots except that three cast-in, sheath wire immersion heating units are used instead of two.

Each heating unit is rated 5 kilowatts. The pot may be operated either on 110- or 220-volts, a-c. or d-c. circuits and the use of three heating units will also permit balanced 3- phase operation.

The pot itself consists of a sheet steel, cylindrical casing in which is supported a cast-iron crucible of the following dimensions: Inside—18 inches in diameter and 15 inches in depth; Outside—29 inches in diameter and 31 inches in depth. The space between the casing the crucible, measuring about three inches, is efficiently insulated with a compact heat insulator. The leads of the heating units are brought over the top of the pot into a connection box fixed to the unit itself.

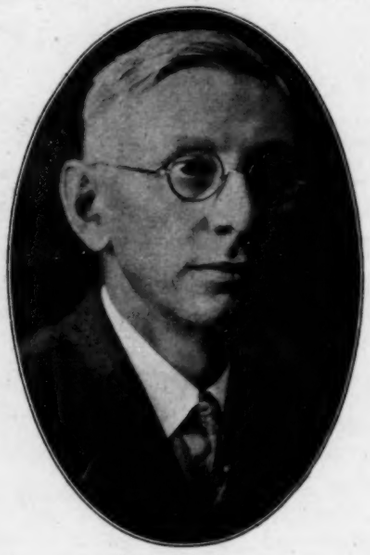
Melting pots of this type are designed for melting lead, babbitt, tin, solder and similar alloys of metals, except spelter or zinc, at temperatures not exceeding 850 degrees.

Full-automatic control is recommended, consisting of a standard automatic control panel and a temperature control instrument equipped with a special bulb for metal immersion.

Separate heating units may be installed in existing installations of melting pots where dimensions permit and where temperatures do not exceed 850 degrees F.

In the recent reorganization of the General Engineering Department of the Westinghouse Electric and Manufacturing Company, Mr. G. E. Stoltz, formerly head of the Steel Mill Section, and well known for his trade activities in that industry, was promoted to Manager of Industrial Engineering.

Mr. Stoltz was born in Gettysburg, Ohio. He received his preparatory school training there, and



G. E. Stoltz

was graduated from the Ohio State University in 1909. Immediately following his graduation he entered the apprentice course of the Westinghouse Company. After finishing this course he entered the Steel Mill Section of the General Engineering Department, first as an engineer and later as section head. He retained this latter title until his recent promotion.

During his activity in the steel mill industry he placed into operation the first alternating current

adjustable speed set in this continent. He also assisted in placing into operation the early reversing blooming mill equipments, and co-operated in the design of the recent single unit reversing equipments.

Mr. Stoltz is a member of the American Iron and Steel Institute, the Association of Iron and Steel Engineers, the A.I.E.E. and the Engineering Society of Western Pennsylvania, and has delivered a number of talks and papers before these various organizations.

Bulletin No. 1560 recently issued by the Hyatt Roller Bearing Company, Newark, N. J., contains data of value to engineers and draftsmen concerned with the designing or development of plant and production equipment.

This Bulletin is supplemental to other Hyatt publications in that it covers in one volume bearing applications to general types of Industrial equipment. Aside from the conventional load and rating tables it includes formulas for determining bearing sizes for specific applications, suggestions for mountings—with drawings—photos of diversified Hyattized equipment and construction details of all types of Hyatt Roller Bearings.

Announcement is made from the executive offices of the Graybar Electric Company of the appointment of E. E. Martin as Manager of the Syracuse (N. Y.) Graybar House, succeeding E. D. Towler who has been appointed Assistant Sales Manager at New York.

Mr. Martin in his new capacity will report to the Manager of the Buffalo Branch House.

Announcement is made by the New York executive offices of the Graybar Electric Company of several changes in management and personnel of the Company's distributing houses in southern territory, effective September 27.

George T. Marchmont, at present Manager of the Company's Richmond (Va.) branch house has been appointed Southern District Manager with headquarters at Atlanta, Ga. Mr. Marchmont succeeds Howard Hall who has been promoted to the staff of Frank A. Ketcham, Executive Vice President of the Company with headquarters at New York.

As Manager of the Southern District, Mr. Marchmont will have under his supervision the Graybar distributing houses at Atlanta, Birmingham, New Orleans, Savannah, Jacksonvillle, Miami and Tampa.

J. H. Pearson, Jr., Manager of the Charlotte, N. C., Graybar house will succeed Mr. Marchmont to the management of the Richmond house.

Succeeding Mr Pearson at Charlotte, N. C., will be Moorman C. Beckner at present a member of the sales staff of the Graybar Richmond house.

A new box or hearth type electric furnace particularly applicable to production work in plants for the heat treating machine parts, and to tempering lathe and planer tools, dies and punches in tool rooms is now being manufactured by the Westinghouse Electric and Manufacturing Company.

The furnace is constructed of a shell of heavy boiler plate, rivetted and bolted to a structural steel frame, and heavy front castings. The heat insulations and the heating chamber are enclosed in the shell. The entire roof is assembled in a frame and bolted to the lower portion of the shell. A feature of this construction is that the roof may be lifted and swung to one side for the inspection or repair of the linings and the heating elements.

The direct radiating heating elements, made of nickel chromium are protected and open, and are assembled in a frame of the same metal. They may easily be removed if necessary. A cast nickel, chromium floor-plate distributes the heat evenly, protects the bottom element, and forms a smooth surface for handling the material in and out of the chamber.

By means of automatic regulation the furnaces are automatically controlled within very close temperature limits, which can be fixed as desired up to the limit of 1850°F. This automatic regulation of temperature permits economy of operation by eliminating improperly heated charges, and reducing the operator's time in attendance.

Three sizes are built having capacities, at 1500°F., 100, 240 and 360 pounds of steel per hour, and with connected loads of 15, 27 and 40 kw. respectively. The smallest size uses single phase, 110-volt current; the middle size, single phase, and the largest size is designed for 1, 2 or 3 phase, 220-volt only.

The National Carbon Company, Inc., Cleveland, Ohio, have prepared a moving picture entitled "Behind the Pyramids" which shows in a very interesting manner the manufacture, application, operation and care of carbon brushes and other carbon products used in the electrical industry.

This picture will be shown before Technical Society Meetings, Operating Department Groups, Engineering College Classes, etc There are three reels of film requiring approximately forty-five minues for showing. Arrangements for showing this film may be made by writing to the Carbon Sales Division, National Carbon Company, Inc., at Cleveland, Ohio, or through their Sales Engineers.

Mr. Ollie Needham, of the steel mill section, General Engineering Department, Westinghouse Electric and Manufacturing Company was recently promoted to Engineer in charge of the Steel Mill Engineering according to a recent announcement of Mr. H. W. Cope, Assistant Director of Engineering.

Mr. Needham was born in Pottsboro, Texas, but received his education in the State of Oklahoma. He was graduated from the Oklahoma Agricultural and Mechanical College with a Bachelor of Science Degree in Electrical Engineering in 1909. He later entered the apprentice course of the Westinghouse Electric and Manufacturing Company, which he completed in two years time. He then entered the Motor Engineering Department for a six month

period and then spent about 4 years in the testing work. Following this he was transferred to the Steel Mill Section of the General Engineering Department, where he has since remained, handling the applications of electricity in Steel Mills.

Mr. Needham, during these years has been in very close touch with developments in the design and application of steel mill electrical equipment, and has assisted in the installation of several large

O. NEEDHAM

important steel mill electrifications at Plants of the Bethlehem Steel Company, of the U. S. Steel Corporation, and also many independent Steel Companies.

Mr. Needham is a member of the Association of Iron and Steel Electrical Engineers and the American Institute of Electrical Engineeers and has presented papers before both of these associations on different occasions. In addition to this Mr. Needham has written several articles for technical press.

In accordance with its well defined program of electrification of the suburban lines entering Philadelphia, the Pennsylvania Railroad has placed an order with the Westinghouse Electric and Manufacturing Company for electrical equipment for 93 coaches, to be used on the Wilmington division. In addition, the contract calls for motors and control for four huge electrical passenger locomotives of the same type ordered from the Westinghouse Company last February.

The car equipment just ordered is a duplicate of that previously developed by the Wiestinghouse Electric and Manufacturing Company for application to the Pennsylvania standard multiple unit coaches. The Pennsylvania Railroad already has 130 of these electric coaches with Westinghouse equipment operating in highly successful service on their Paoli and Chestnut Hill branches and the new order calls for the use of the same electrical equipment.

These coaches will be put into service on the Wilmington division now being modified for electrical operation and, consequently, the Pennsylvania Railroad will proceed with the electrification of the West Chester branches and the Bristol section of the New York main line for the operation of which additional equipment will be required later on.

The entire work of electrification, as is well understood, is a preliminary step to the removal of the present main station at Broad Street, Philadelphia, to the new site in West Philadelphia with the future Broad Street terminal restricted to the handling of suburban electric trains to be brought into the center of the city by means of a proposed Filbert Street subway. The equipment just ordered is one of the largest placed in this territory in recent years and supplements two previous orders given the Westinghouse Company this year for the same type equipment for a total of 28 coaches, delivery of which is now being made.

The locomotive equipment included in the new contract will be the third order placed by the Pennsylvania Railroad with the Westinghouse Company. The first order calling for three of these equipments was placed early in 1924 and was followed by a second order for six additional units last February. The new locomotives have a continuous rating of 3730 horsepower each, and, thus, as regards both tractive effort and speed will compare with the greatest existing steam locomotive. The mechanical parts of these locomotives were built by the motive power department of the Pennsylvania Railroad at Altoona under the personal direction of J. T. Wallis, chief of motive power.

When completed, these locomotives will weigh approximately 400,000 pounds, with a total length of 68 feet. The locomotive will have a 2-8-2 wheel arrangement with the motors arrange two per jack shaft. Each jack shaft in turn has two pairs of "drivers" almost 7 feet high, or nearly a foot higher than the average man. The gear ratio of each locomotive will permit a sustained speed of 70 miles per hour if desired.

The new locomotives when finished will be dispatched to the New York division for operation in the electrified section between Manhattan Transfer and the Pennsylvania station.

"The railroads have been making great strides in efficiency since their return from government operation. Traffic handled within the past month exceeds all previous records in American and this has been accomplished with a freedom of movement and an efficiency undreamed of during the dark days of the war and subsequent thereto. It is confidently believed that railroad conditions as well as business generally are reaching their normal state and that growth may now be expected to continue year after year just as obtained before the war.

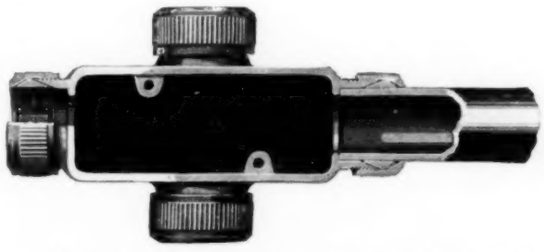
"This means provision for increased capacity for traffic movement and in many cases electrification to enable increased service to be undertaken. Where physical restrictions make increased tracks and facilities impossible, it is well known that electrification will double the capacity of a railroad as compared with steam operation, the latest evidence of this

being the experience of the Virginian Railway which completed extension of its electrification to Roanoke, Virginia, last week. Here train operation under mountain grade conditions and for fast freight train service is demonstrating the maximum realized in the world today.

"Nine thousand-ton trains are being hauled by single locomotives at 28 miles an hour and mountain grade operation is being accomplished with 20,000-horsepower per single train, which is more than double any performance accomplished by steam."

Appleton Electric Company, 1701 Wellington Avenue, Chicago, Ill., announces an improved line of No-Thread Unilets which will be manufactured in addition to the well known line of threaded Unilets made by this company for many years.

No-Thread Unilets of a different design were made by this company more than 15 years ago and the new lines shows many decided improvements over the old as well as over any other similar fittings on the market. It is claimed that these fittings are a considerable time saver as it is not necessary



to cut threads. There are no loose parts which insures the utmost simplicity and efficiency. It is only necessary to cut the conduit, slip it into the No-Thread Unilet, tighten the knurled nut which insures a mechanically secure joint, a perfect running ground and a stronger job in considerably less time than is ordinarily required.

A sectional view of this improved Unilet shows its simple design. The tapered steel ring is squeezed onto the conduit by the knurled nut—from the outside. There is no change in the circumference of the threaded hub, therefore there is no tendency to strip the threads of either nut or hub.

This same ring has on its inner surface three projecting beads that pierce through the conduit enamel, thus establishing a metal to metal contact and insuring a perfect running ground All standard Unilet covers and fittings are interchangeable with the No-Thread Unilets. Further information can be had by writing the manufacturer.

The air supply for the new furnace of the Mystic Iron Works at Everett, Mass., is furnished by the new type of General Electric blast furnace blower. Two 45,000 cubic-foot units have been installed as part of the furnace equipment, the units being duplicates, one to be permanently in service and the other to be reserved as a spare. This is the first opportunity General Electric has had of demonstrating its new blast furnace blower to the trade. The plant was placed in blast September 27.

Each of the two blower units consists of a 3-stage, water-jacketed blower with radial flow impellers capable of delivering any volume up to 45,000 cubic feet of air at pressures up to 30 pounds. The drivers are 8-stage, condensing, General Electric turbines with multiple valve control. Each turbine is equipped with the usual emergency and speed governors, the latter acting as a pre-emergency governor without shutting down the unit. In ordinary service, however, the blower is controlled by the new General Electric constant volume governor.

The installation of these blowers marks the culmination of 20 years of General Electric blower manufacture and development. The first commercial application of a centrifugal compressor in this country was made by the General Electric Company in 1906, for the purpose of furnishing air for combustion purposes in conjunction with an oil fired furnace. This was followed by additional units for such applications as cupola blowing, pneumatic ash handling systems, blowing water gas generators, pneumatic cash conveying systems, gas boosting and finally, in 1909, the General Electric Company installed its first centrifugal blast furnace blower in the plant of the Empire Steel & Iron Co. at Oxford, N. J.

This first blast furnace blower was limited to a maximum speed of 1800 r.p.m. because, at that time, there was no turbine of the required capacity available to drive the machine at higher speeds. It was therefore necessary to use six stages in the air end of the unit, in spite of the fact that the maximum air pressure was but 22 pounds. Furthermore, available materials at that time would not permit the design of a machine of this character for operation at higher speeds.

The cooling of the air end of this first machine was very limited; the air wheels were built after the fashion of the impellers in fans—in other words, the blades were riveted to the wheel disc. The design of the conversion passages immediately beyond the wheel was such as to result in rather noisy operation.

Because of the novelty of the centrifugal type of blast furnace blower, and because of the lack of appreciation of its characteristics, the steel industry was slow in adopting it. However, in 1910, three 10,000 cubic-foot, 30-pound blowers were installed by the General Electric Company at the Iroquois Iron Company plant at South Chicago. In the short period of time intervening, experience both with drivers and the construction of blowers, combined with improvements in materials, permitted the design of a unit which had a maximum speed of 3250 r.p.m. Notwithstanding the higher air pressure, these machines were designed with three stages in the air end.

By 1912, with further improvements of materials and design, General Electric was able to build a machine with a maximum speed of 3800 r.p.m., and such a unit was installed by the E. & G. Brooke Iron Co. of Riddlesburg, Pa. By this time confidence in the centrifugal type of blast furnace blower had increased to the point where this machine was installed with very inadequate spare equipment (half the capacity required by the furnace), and it has since been practically the sole source of air supply in the normal operation of that furnace.

More recently the General Electric Company has introduced its new line of centrifugal compressors,

of which 459 units have been installed throughout the United States within the last two and one-half years. The installation at the Mystic Iron Works, however, is the first of the blast furnace type to be put into operation, although a number of other units will go into operation in the next few weeks, including the following:

Two 45,000 cubic-foot, 35-pound Bessemer converter blowers at the Woodlawn plant of the Jones & Laughlin Steel Company; two 50,000 cubic-foot blast furnace blowers at the Central Furnace Company, Massillon, Ohio; one 60,000 cubic-foot unit at the National Tube Company, Loraine, Ohio; one 45,000 cubic-foot unit at the Perry Iron Company, Erie, Pa., and one 35,000 cubic-foot unit at the Bourne Fuller Co., Cleveland, Ohio.

The Harnischfeger Corporation, Builders of Overhead Electric Traveling Cranes and Gasoline Driven Excavators, announce a complete new line of Excavators. Every feature on these machines was designed from the point of view of the practical dirt mover.

These new P&H models (built in sizes ½, ¾, 1 and 1¼ cubic yards capacity) are all steel from the tip of the boom to the corduroy shoes. The revolving frame, car-body, drum side stands, etc., are heavy one-piece steel castings.

This heavy cast steel frame construction cannot wear out. After many years of service these castings will be as good as new. Contrast P&H Unit Cast Steel Construction with some of the machines employing built up frames and it is easily understood why the P&H is so long lived.

The Unit Cast Steel Construction insures permanent alignment for all working parts—there is nothing to work loose. As a result the shafts always run true and there is less wear in the bearings and in the gears.

The purpose of this unit steel construction is to secure rigidity. To get the full benefits of this construction all castings are fully machined at the joints and bearing points.

P&H Excavators have less tail swing than any other machines of similar capacity. This is especially important to the basement contractor or to any one who works in narrow alleys, since a machine of short rear end radius has no trouble in working close to basement walls or in swinging around within a narrow space. This eliminates much expensive hand trimming.

Another place where an excavator of short tail swing is valuable is in the excavation of narrow mountainous roads. In some cases by using an excavator of short tail swing like the P&H it is possible to narrow the width of the road so that thousands of yards of excavation can be saved.

Crowding motion: The success of any shovel depends upon the crowding motion. Here are some of the features of the P&H "Crowd."

1. It is positive and will bite into the toughest soils.

2. It can force the dipper above the boom point. This is valuable in loading trucks on top of a bank.

3. Crowding is independent of hoisting. The dipper can therefore cut a level floor or any slope of bank.

4. Dipper can be reversed rapidly. It is easy to shake off sticky soil.

5. No complicated air or steam engines on the boom and no cables to wear out.

6. Full power of the motion can be thrown in the "crowd."

Two Speed Tractions: P&H Tractions are provided with two speeds. The high gear provides a fast travel speed between jobs. The low speed gives tremendous tractive effort and enables the machines to pull through the deepest mud or to climb grades as steep as 35%.

Interchangeability: All P&H Models can be used as shovel, skimmer scoop, hoe, dragline, pile driver, clamshell or crane. The change from one model to another is quickly made by means of a patented drum spider and lagging. It is not necessary to change the drum or shaft in making the change but merely the lagging.

High Speeds: All P&H Machines are provided with extra large motors so that the line swing and travel speeds are fast. This gives the machines great capacity.

Shipped on Standard Flat Car: All P&H Shovels can be shipped on a standard flat car without dismantling. Drag-lines and cranes are also shipped completely dismantled with the exception of the boom which is unbolted at the center. The Model 700 is the largest machine built which can be shipped in this way.

Gears and Shafting: All shafts are of Chrome manganese steel, the heavy duty shafts being forged and heat treated. Gears are of heat treated steel with teeth cut twice to insure smooth operation and minimum power loss.

The Packard Electric Co. announces a complete line of Steel Meter Cabinets is now available for use in conjunction with outdoor primary metering installations. These cabinets can be used with Packard Type "PCW" Metering Sets where it is not convenient or advisable to place meters indoors.

Cabinets are all steel welded with hinged door opening the entire front—providing sufficient space for mounting the meters on a wooden backboard fastened securely to the rear wall. Sufficient space is left behind the back board to conceal wiring if desired.

Overhanging roof and snug fitting door make the cabinet absolutely weatherproof and protect meters from rain, snow or sleet.

The walls are of heavy gauge copper bearing steel to resist rust and prevent damage from rough handling.

Clasp and means for locking enable the box to be made secure from tampering. Padlock is not furnished.

Standard transformer hanger irons are furnished so the cabinet may be easily mounted at the base of a pole. Hangers are bolted to slotted steel lugs welded on the back of the cabinet.

Cabinets are painted with heavy coat of battleship gray.

Any size cabinet can be furnished for special meter combinations but the more usual requirements can be met with the three standard sizes.

TWENTY-SECOND ANNUAL MEETING

(Continued from page 111)

hand knowledge of what the Steel Industry is doing and at the same time extends possibilities to the wide awake engineer to improve upon obsolete and antiquated methods, if any exist.

In a recent copy of one of the trade journals under the title "Germany Showing the Way," it states that Germany's comeback is largely due to working like beavers, living temperately, and co-operating in ways that in British eyes look almost criminal. It is alleged that among German Industrialists, there is an unlimited exchange of information, that there are no longer any secrets, technical or otherwise, and that there is much pulling together for the common welfare. Secrecy in technical operations is a perpetualizer of bad practice. The plant with closed doors is pretty sure to be doing things whereof its management ought to be ashamed, and often is.

The Industrial success of America is due, in no small degree, to the free exchange of information such as we have been enjoying today. If you believe in this policy, and I think you do, otherwise you would not be here, help the movement along and extend to us the opportunity to visit your plant.

Referring briefly to the aims and work of our Association, it is our aim to make the engineer more useful to his company. Our work is largely done by committees which are composed of the best and most able men in their particular line—in fact, authorities in their work.

During the past year the Safety Section, Mr. C. L. Baker, Chairman, has provided us with a set of rules entitled "Rules for the Safe Operation of Electric Overhead Traveling Cranes," which are being adopted by all the Steel Mills.

The Combustion Section, Mr. H. C. Siebert, Chairman, has been studying methods to increase economies in the operation of blast furnaces, open hearth furnaces, heating furnaces and boiler plants.

The Papers Committee, Mr. C. S. Proudfoot, Chairman, has been successful in procuring most interesting and educational subjects. In the August issue of Iron and Steel Engineer, for example, you have a valuable treatise on different types of control. Such a paper is valuable, not only to the engineer but also to the foreman and sub-foreman and should be passed along the line, as well as many other papers of a similar nature.

The Electric Development Committee, Mr. W. S. Hall, Chairman, has compiled a list of all electric mill drives over 300 HP, it being the first list of its kind ever published.

It might be interesting to add here that European countries are far behind us in electric developments. Our workman now has at his disposal an average of 3¾ HP. This is about double the amount per man for England, the next largest user of electric power.

The Electric Heat Committee, Mr. W. P. Chandler, Chairman, has rendered a report detailing the present status of electric heat, with particular reference to the viewpoint of the operating features.

The Standardization Committee, Mr. A. C. Cummins, Chairman, has been actively engaged in the development of a standard type of D. C. mill type motor. The committee has secured the co-operation of the various electrical manufacturers and the steel companies. This accomplishment will make possible economies in the design and construction of new operations and greatly reduce inventories. So far has this work progressed that it is to be incorporated as a report in the October issue of Iron and Steel Engineer under the title of "Report of the Standardization Committee of the Association of Iron and Steel Electrical Engineers for the year 1926. The Standardized Commutating Pole Mill Type Motor."

As to our financial status, will only say at this time that the Association has been completely established and continues to operate on a sound financial basis.

We must not pass unnoticed, our official publication, printed monthly and containing all our transactions, which is sent to our membership. The Iron and Steel Engineer aims to give you good editorials, dealing on pertinent subjects. It contains, as before mentioned, all our technical papers together with their full discussions. In addition, it carries a high class of valuable advertising material, very important to the "Steel Mill Man" and arranged in such a manner as to be a credit to any publication.

As to our future growth and activities, we are constituted for the advancement of engineering in the Iron and Steel Industry. If we can show our membership a fair return for their activities, we need have no fear and our future is assured. Be it remembered, however, that we must have active members and workers and that we must produce results. The best results are those that show a reduction in the cost per ton of steel produced.

In closing, I wish to announce the result of the election of officers for the year 1927:

S. S. Wales, President.
A. J. Standing, First Vice President.
C. S. Proudfoot, Second Vice President.
James Farrington, Treasurer.
F. W. Cramer, Secretary.
C. L. Baker, Director.
H. C. Siebert, Director.
A. G. Place, Director.
R. S. Shoemaker, Director.
F. L. Collins, Director.

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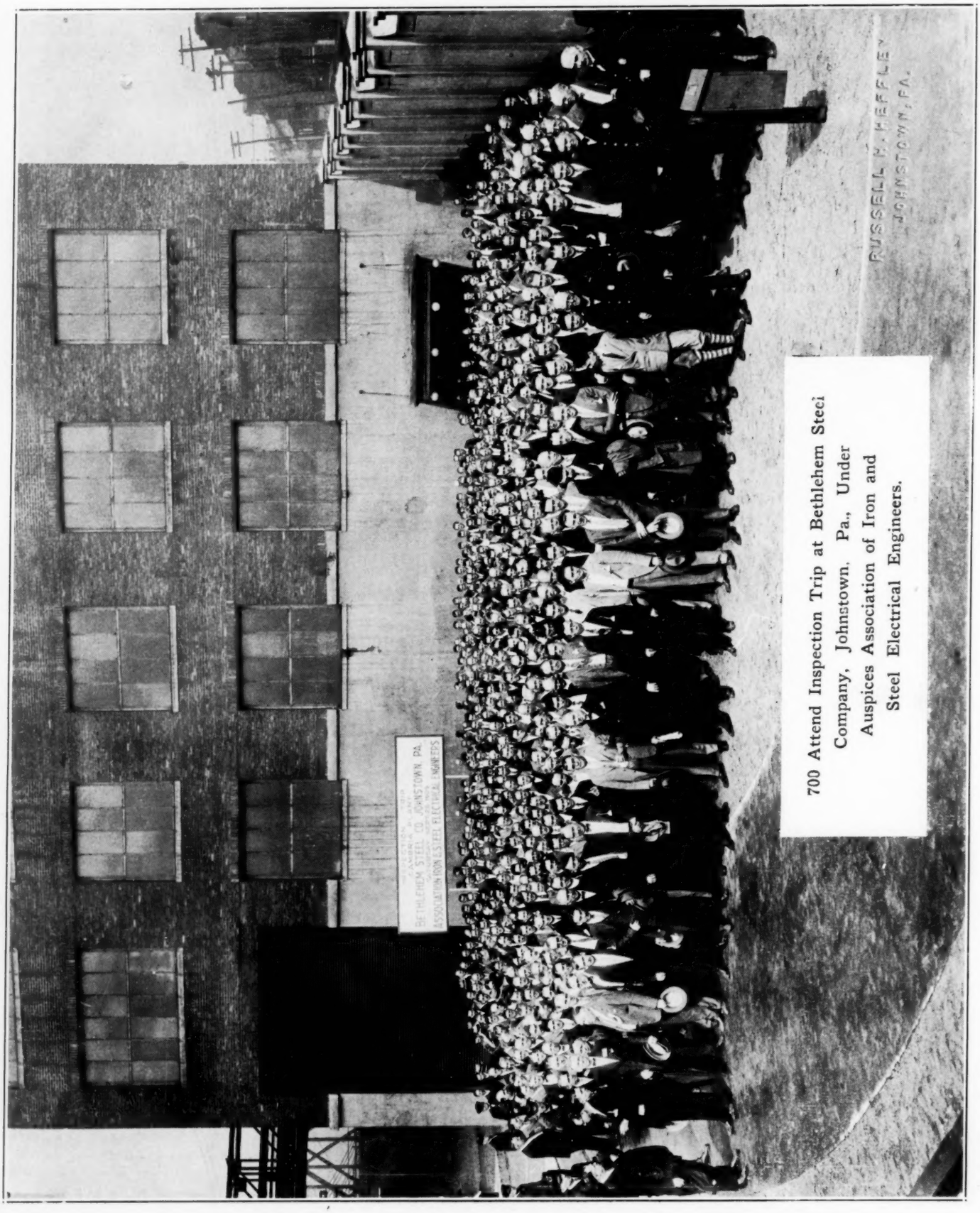

700 Attend Inspection Trip at Bethlehem Steel Company, Johnstown, Pa., Under Auspices Association of Iron and Steel Electrical Engineers.